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Correspondence concerning subscription, back issues, publication, etc. should be addressed to the editor: Hisham K. El-Hennawy

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Distribution of the "*Euscorpius carpathicus*" complex (Scorpiones: Euscorpiidae) in Turkey

Ayşegül Karataş
Niğde Üniversitesi, Fen-Edebiyat Fakültesi, Biyoloji Bölümü,
51200 Niğde, Türkiye
E-mail: leiurus9@hotmail.com

Abstract

This study presents old and new distributional localities and some morphplogical information concerning "*carpathicus* complex" of the genus *Euscorpius* Thorell, 1876 (Scorpiones: Euscorpiidae) in Turkey. Also taxonomic affinities of the taxa are discussed.

Keywords: Scorpiones, Euscorpiidae, *Euscorpius*, *carpathicus* complex, Turkey, distribution, morphology, taxonomy.

Introduction

Although several studies were made about Turkish *Euscorpius* Thorell (Birula, 1898, 1917a, 1917b; Hadži, 1930; Schenkel, 1947; Vachon, 1951, 1966; Tolunay, 1959; Kinzelbach, 1975, 1982; Bonacina, 1980; Fet, 1986, 1987, 1993, 1997; Lacroix, 1995; Kritscher, 1993; Crucitti & Malori, 1998; Fet *et al*., 2003a), the species composition and taxonomic rank of most populations are still not clear (Fet & Braunwalder, 2000; Fet *et al.*, 2004).

Birula (1898) described *E. ciliciensis* Birula, 1898 from the Middle Taurus of Turkey. *E. ciliciensis* were considered either subspecies of *E. germanus* (Vachon, 1951, 1966) or a taxon belonging to *E. carpathicus* s.str. (Kinzelbach, 1975). Bonacina (1980) reestablished *E. mingrelicus* (Western Balkans and Anatolia to the Caucasus) as a "good" species and limited *E. germanus* (C.L. Koch) to the Alpine regions of Italy and described *E. m. phrygius* as a new subspecies from Turkey (Western Anatolia). Bonacina (1980) used the ratio of et-est/est-dsb and gave the ratio ca. 1 in *E. germanus* and between 1.5 and 3 in *E. mingrelicus*. Fet (1986) confirmed that *E. ciliciensis* type material of Birula belongs to "*E. mingrelicus* complex". Fet (1993) analyzed the morphological features of *E. m. mingrelicus* from Georgia and Russia. Lacroix (1995) described three new subspecies of *E. mingrelicus* excluding the three existing subspecies (viz. *E. m.*

mingrelicus, *E. m. ciliciensis* and *E. m. phrygius*) and limited the nominotypic ssp. *E. m. mingrelicus* to the Transcaucasia. Of these, *E. m. legrandi* was described from Bolu, *E. m. uludagensis* from Uludağ (Bursa) and *E. m. ollivieri* from along the coast of Black Sea between Zonguldak and Artvin. According to the latest treatment, six subspecies of *E. mingrelicus* are found in Turkey (Fet & Braunwalder, 2000, Fet *et al*., 2004). But taxonomic status of these subspecies is still unclear and questionable.

E. carpathicus was reported from different localities by Hadži (1930), Schenkel (1947), Vachon (1951), Tolunay (1959), Kinzelbach (1975) and Crucitti & Malori (1998). Fet & Braunwalder (2000) discussed current problems in taxonomy and biogeography of the scorpions of the Aegean area. Fet *et al*. (2003a) presented first DNA phylogeny of the genus *Euscorpius* including specimens collected both close to the type locality and another population from western Anatolia. Fet *et al*. (in press) discovered that presence of low genetic divergence accros the range of *E. italicus.*

Recent studies about *E. carpathicus* complex were based mainly on morphometric character sets and DNA analysis. Fet & Soleglad (2002) elevated the Balkan population to the species level as *E. hadzii*, verifying species status of *E. koschewnikowi* from Greece, and also quoted some Italian subspecies of *E. carpathicus* to species *E. sicanus*. Gantenbein *et al*. (2001) elevated the Balearic Island subspecies *E. c. balearicus* to species level as *E. balearicus*. Fet (2003) elevated subspecies of *E. c. tauricus* to species status as *E. tauricus*. Fet *et al*. (2003b) elevated *E. c. sicanus* known from Italy, Malta and Greece to species level as *E. sicanus* and limited the distribution of *E. carpathicus* to Romania.

The purpose of this study is to present details on morphological features (total length, number of patellar trichobotria (ventral and external series), number of pectinal plates and ratio of et-est / est-dsb) of two different forms, along with old and new distributional localities of *Euscorpius carpathicus* complex from Turkey.

Material and Methods

The specimens collected between the years 1998 and 2005 from different localities in Turkey were studied (Fig. 1). Specimens were investigated and measured with the stereomicroscope Olympus SZX9 equipped with 0.1 mm accuracy micrometric ocular. Total length was measured with 0.5 mm accuracy calipers. Scorpions were identified according to diagnostic external morphological features such as total length, carination of metasoma and number and position of the trichobothria on the pedipalp and the ratio of the distances between trichobothria et-est and est-dsb on the fixed finger of pedipalp. Diagnosis of each form is based on the material examined. The specimens were collected from different localities of Turkey and were preserved in 70% alcohol. A total of 56 pooled specimens were analysed. Trichobothrial formulae were given according to standard techniques (Fet, 1993, 2000).

Abbreviations

Dp: Number of pectinal tooth.

V: Number of trichobothria on the ventral aspect of pedipalp patella.

Te: The same on the external aspect including the following et, est, em, esb, eb_a, eb,

et: terminal; **est**: subterminal; **em**: median; **esb**: suprabasal; **eb_a**: basal “a”; **eb**: basal.

et-est/est-dsb: The ratio of distance between the trichobothria et (external terminal)-est (external subterminal) and est (external subterminal)-dsb (dorsal suprabasal) on the fixed finger of pedipalp chela.

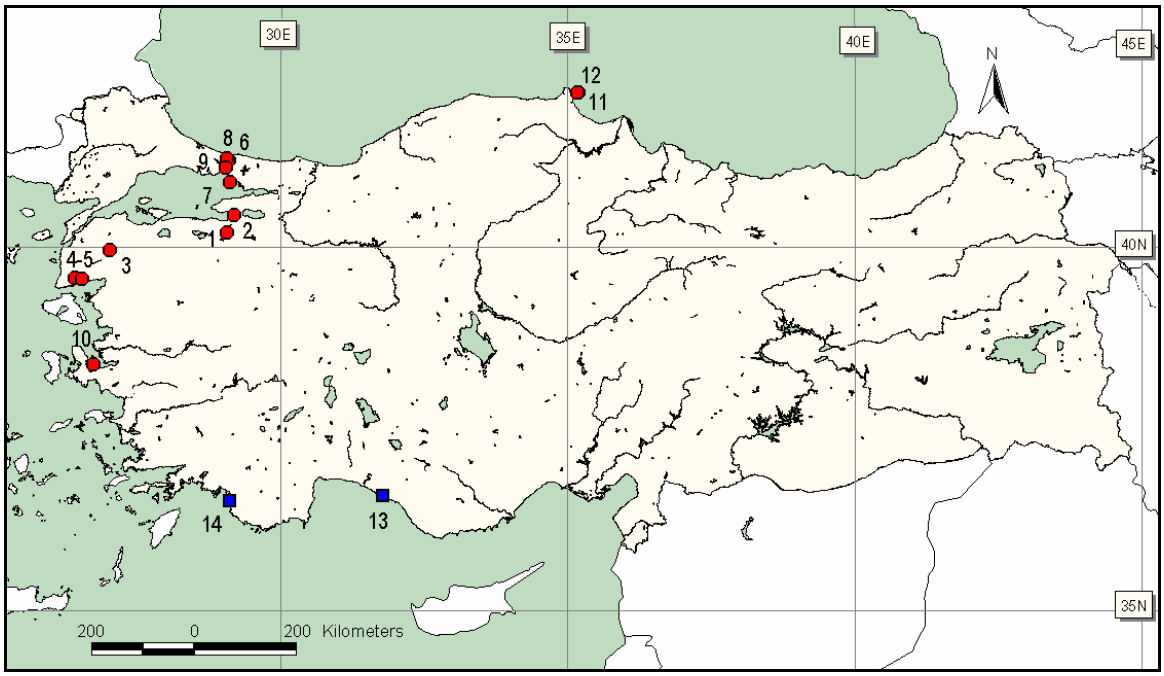

Fig. 1. Map of sampling localities. ***Euscorpius* sp. 1**: 1. Bursa, 2. Gemlik, Umurbey, 3. Çanakkale: Ayvacık, 4. Ayvacık, Hemdemtepe, 5. Çan, Terzialan; 6. İstanbul, 7. Büyükada, 8. Sarıyer, 9. Üsküdar, Çengelköy; 10. İzmir: Urla, Menteş; 11. Sinop, 12. Ada vicinity. ***Euscorpius* sp. 2**: 13. Antalya: Alanya, Avsallar; 14. Muğla: Fethiye, Kelebekler Valley.

Results and Discussion

According to the scored morphological features, all studied specimens were given in phenotypic groups. Below records of each group (with the original detailed trichobothrial scores, mean value of et-est/est-dsb and number of pectinal plates) were given. Number of scored pedipalps was given in brackets.

Family: Euscorpiidae Laurie, 1896
Genus: *Euscorpius* Thorell, 1876
Subgenus: *Euscorpius* Thorell, 1876

***Euscorpius* sp. 1 ("*carpathicus* complex") (cf. *E. koschewnikowi* and cf. *E. carpathicus* subgroup A1 sensu Fet, 2000)**

Material Examined: (total 52 specimens; 30 ♀♀, 22 ♂♂): Bursa: Centrum, 17.VIII.2005: 2 ♂♂ (2005/33); Gemlik, Umurbey, 14.VII.2003: 1 ♀ (2003/234). Çanakkale: Ayvacık, 08.IX.2003: 1 ♀ (2003/19); Ayvacık, Hemdemtepe picnic site, 08.IX.2003: 1 ♂, 3 ♀♀ (2003/19.1-4); Çan, Terzialan Vil., 07.VII.2003: 1 ♀, 1 ♂ (2003/12. 1-2). İstanbul: exact locality unknown, –.II.1999: 1 ♂ (1999/33); İstanbul: Adalar, Büyükada, 01.VII.2004 1 ♀ with 23 juv. (2004/53), ibid., 3 ♀♀ (2004/57. 1-3), 01.VIII.2004: 10 ♀♀, 13 ♂♂ (2004/35. 1-23); Sarıyer, 25.VII.2002: 3 ♂♂, 1 ♀ (2002/75.1-4); Üsküdar, Çengelköy, 16.IX.2001: 1 ♀ (2001/28). İzmir: Urla, Menteş Military Area, 18.VI.2004: 4 ♀♀ (2004/101. 1-4). Sinop (Centrum): Balatlar Church, 17.IX.2003: 1 ♂, 1 ♀ (2003/37.1-2), 23.VII.2004: 1 ♀ (2004/57); Ada vicinity, 14.IX.2003: 2 ♀♀ (2003/41.1-2).

Morphology: Total length generally was up to 30-35 mm in adults, but up to 38 mm in the largest specimens, collected from Bursa, Çanakkale, and Sinop (Fig. 2). Mean value of et-est/est-dsb was 1.33 ± 0.21 (Range: 1.27 - 1.40). Pedipalps, especially manus, were very well developed and large. Cutting edges of pedipalp fingers had a very strong basal scallop in adult males, and were contiguous in females; movable finger had a well developed median lobe in adult males. Colouration changed from medium brown to orange brown; pedipalps and carapace are the darkest; carinae of pedipalps were darker, and chelicerae, mesosoma, legs and telson were lighter and yellowish brown. Metasoma was relatively thin and sylindirical in shape, but not smooth. Dorsal carinae of metasomal segments I-IV were very sparsely and finely granulose; ventromedian and ventrolateral carinae of segment V had moderate granules and intercarinal spaces bears dense and fine granules.

Trichobothrial counts of pedipalp patella: Among the 52 examined specimens, the measurements were as follows (in parenthesis, number of scored pedipalps): external: eb: 2 (1), 4 (103), eb_a: 2 (1), 4 (103), esb: 2 (104), em: 3 (3), 4 (101), est: 3 (1), 4 (103) and et: 4 (2), 5 (28), 6 (74), and V: 6 (1), 7 (26), 8 (77).

Pectinal tooth counts were scored as follows; in females one specimen lack of pectines, 6-7 (1), 7-7 (19), 7-8 (7), 8-8 (2). In males, 8-8 (2), 8-9 (6), 9-9 (12), 9-10 (2).

Fig. 2. Adult male (left) and female (right) *Euscorpius* sp. 1 ("*carpathicus* complex") from Turkey. Male from İstanbul (2004/35-1), female from Sinop Ada vicinity (2003/41).

Comments: This species was recorded by Hadži (1930) from İstanbul and Crimea. In this study, the specimens collected from İstanbul under the name *E. c. oligotrichus*, were reported with a total length up to 30.5 mm, V: 7-9, Te: 24 and number of pectinal plates: 9-10 in males. Detailed trichobothrial analysis of *E. carpathicus* from the Crimea were given by Fet (1997) and it was elevated to species rank as *E. tauricus* according to DNA analysis by Fet (2003). Schenkel (1947) recorded one female from Havza (Samsun), Tolunay (1959) from Sinop and Vachon (1951) from İstanbul. Kinzelbach (1975) recorded this species from Çanakkale, Trakya, Eğridir (Isparta), Borçka (Artvin), Amasya, the Middle Taurus, Denizli and İstanbul with the name *E. carpathicus* s.str. First DNA phylogeny of the genus *Euscorpius* including specimens collected close to the type locality of *E. ciliciensis* Birula, and also from western Anatolia suggest that the closest

taxa to the analyzed Anatolian populations are European species *E. gamma* Caporiacco, 1950 and *E. germanus* (C.L. Koch, 1837) but not the "*E. carpathicus*" species complex (Fet *et al*., 2003a).

E. carpathicus was traditionally treated as one species widespread from Baleares to Crimea (Fet *et al*., 2000). "*E. carpathicus* complex" is a complicated species complex and currently under revision using both morphological and molecular techniques (Fet & Soleglad, 2002; Fet *et al*., 2003b; Gantenbein *et al*., 2001). Currently Fet & Soleglad (2002) restricted the scope of *E. carpathicus* (Linnaeus, 1767) s.str. to Southwestern Romania and seven subspecies were revalidated as full species in this complex. One of them is *E. koschewnikowi* Birula, 1900 from northeastern Greece.

I compared my specimens with *E. koschewnikowi* and found some differences: In another study (Fet & Soleglad, 2002) the trichobothrium V4 was seen to be situated on the external surface, removed from the exteroventral carina of *E. koschewnikowi*. In this study, in all specimens given as cf. *E. carpathicus* or cf. *E. tergestinus,* V4 was situated on the ventral surface, internally from the exteroventral carina. As for the metasomal segments, all segments are considered to be longer than wide in both sexes of *E. koschewnikowi* (Fet & Soleglad, 2002) but in studied specimens from Turkey, while in males all segments (I-V) were longer than wide, in all females segment I was wider than long and in all the other segments (II-V) were longer than wide. Number of pectinal plates of *E. koschewnikowi* were given as 6-7 in females and 8 in males (Fet & Soleglad, 2002). Most of my male specimens have pectines with 9 teeth. Only one male from Ayvacık (Çanakkale) and one of total 13 males from Büyükada (İstanbul) have pectinal plates with 8-8 teeth. Also Çanakkale specimens are respectively small, adults were only up to 25 mm, and had more reduced metasomal carination and relatively less developed pedipalps. Teruel *et al*. (2004) reported *Euscorpius* sp.1 ("*carpathicus* complex") from Bulgaria with v: 6-7, et: 5, Dp in females: 7-7 and in males: 8-8. This occurred quite rarely in my examined specimens.

Fet (2000) separated a group named *E. carpathicus* subgroup A1 belonging to "*carpathicus* complex" with modal trichobotrial formulae as V: usually 7 to 8 and et from 5 to 6 from Bulgaria and Greece that corresponds to hybrid subspecies *E. c. candiota* Birula, 1903 evaluated by Kinzelbach (1975). Trichobothrial features of my specimens conform with that of *E. carpathicus* subgroup A1 stated by Fet (2000).

Euscorpius sp. 2 ("*carpathicus* complex") (cf. *E. tergestinus* and cf. *E. carpathicus* subgroup A3 sensu Fet, 2000)

Material Examined (4 specimens; 3 ♂♂, 1 ♀): Antalya: Alanya, near Avsallar, 15.IX.1996: 1 ♂ (1996/37), 20.VII.1998: 1 ♂ (1998/18); Muğla: Fethiye, Ölüdeniz, Faralya, Kelebekler (Butterflies) Valley, 23.VIII.2004: 1 ♂, 1 ♀ (2004/38.1-2).

Morphology: Total length was up to 25 mm, pedipalps, carapace, metasomal segments were brown, mesosoma was light brown, telson and legs were yellowish light brown (Fig. 3). Pedipalps were moderately developed, scalloping of fingers was prominent especially in males. Dorsal internal and ventral internal carinae of femur and patella were well developed. Internal surface of femur bears serrulated to crenulated rows of granules. Dorsal carinae of segments I-IV were distinctly granulate, with moderately developed granules and could be seen on ¼ proximal part of segment V. Ventromedian and ventrolateral carinae of segment V were distinctly and moderately granulated. Ventrolateral carinae could be seen also on ¼ distal portion of the segment IV.

Trichobothrial counts of pedipalp patella: Among the four examined specimens, these measurements were as follows (in parentheses, number of scored pedipalps): external: eb: 4, eb_a: 4, esb: 2, em: 4, est: 4 and et: 6 in all 8 pedipalp patella. Ventral, V: 10 (3), 9 (4) and 8 (1). There are no differencies in counts of external series. Mean value of the ratio of et-est/est-dsb (in 8 patella) was measured as 1.2.

Pectinal tooth counts were scored as follows; in females: 6-7(1); in males: 9-9(1), 10-10(1), 8-9(1).

Fig. 3. Adult male (left) and female (right) *Euscorpius* sp. 2 ("*carpathicus* complex") from Turkey. Male and female (2004/38. 1-2) from Fethiye (Muğla).

Comments: Kinzelbach (1975) notified a species with the name *E. mesotrichus* with Tv: 10-14. This species was recorded from Şile (İstanbul) (TPT: 11) and on the coast of Black Sea and Adalar (Prinkipos) Islands in the Marmara Sea (TPT: 10-13). Kinzelbach (1982) recorded *E. mesotrichus* from Korikos (Mersin: Kızkalesi) and Ephesus (İzmir: Selçuk). The occurence of this form in İstanbul was also suspected by Fet & Braunwalder (2000). According to my recent findings, *E. carpathicus* s.l. with V= 9-10 occurs only along the South and Southwestern coast of Turkey and *E. carpathicus* s.l. with V= 7-8 (8 in 74% in scored pedipalp patella) is found in Aegean, Marmara and Black Sea regions (Fig. 1). Also Crucitti & Malori (1998) recorded *E.* cf. *carpathicus* from Antalya (Güzelsu, Adiller, Manavgat) and Konya (Çamlık) with TIT (V): 6-13 and em: 3 (2), 4 (8).

Currently Fet & Soleglad (2002) applied the name *E. tergestinus* to most of the western populations of former *E. carpathicus* (France, Italy, Slovenia, and Croatia) and the name *E. sicanus* to many Greek populations; at least several more forms of the "*carpathicus* complex" were considered as present across the Balkans, all on Aegean islands and in southern Turkey (Fet *et al*., 2004). The most important feature separating *E. sicanus* from *E. tergestinus* and another related species, e.g., *E. balearicus*, is its external patellar series eb (and in some populations, also series eb_a) has 5 trichobothria. All specimens examined of *E. tergestinus* and *E. balearicus* possess only 4 trichobothria in these series (Fet *et al*., 2003b). But in the specimens collected from Turkey, series eb and eb_a always had 4 trichobothria. V4 was situated on the external surface in a dimple in *E. tergestinus* (Fet & Soleglad, 2002); however, V4 situated on the ventral surface, inner side of the exteroventral carina in all studied specimens.

Fet (2000) separated a group named *E. carpathicus* subgroup A3 belonging to the "*carpathicus* complex" with modal trichobotrial formulae as V: usually 8-10 and et from

6 to 7 from Aegean Islands (Greece). Trichobothrial features of my specimens conformed with those of *E. carpathicus* subgroup A3 of Fet (2000).

It will be possible to conclude whether some features of *E. carpathicus* sp. 2 (e.g. carination of pedipalps and metasomal segments, trichobothrial formulae, number of pectinal plates) conform with that of *E. tergestinus* and trichobothrial formulae conform with *E. carpathicus* subgroup A3, only after analysis of both morphology and DNA of all populations from Balkans to Turkey. Based on the results of my study, it seems fit to keep these as *E. carpathicus* sp. 1 and sp. 2 from "*carpathicus* complex". Further morphological and DNA analysis (Fet *et al*., in press) will depict the relationships of *E. carpathicus* populations from Turkey with other Balkan and Greek populations more clearly, as well as the position of Turkish populations in the "*carpathicus* complex".

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Distribution and Systematic Status of *Euscorpius italicus* (Herbst, 1800) (Scorpiones: Euscorpiidae) in Turkey

Ayşegül Karataş
Niğde Üniversitesi, Fen-Edebiyat Fakültesi, Biyoloji Bölümü,
51200 Niğde, Türkiye
E-mail: leiurus9@hotmail.com

Abstract

In this study, the systematic status of *Euscorpius italicus* (Herbst, 1800) was investigated based on morphological features of 156 specimens (77 females, 79 males) collected from the Marmara, Karadeniz, and north-eastern Anatolia area in northern Turkey, specifically. New data on the distribution of *E. italicus* in Turkey are presented, including one record in Kars Province in the north-eastern part of the country, which has a naturally disjunctive distribution. Turkish material was compared to the European samples with respect to trichobothrial features, pectinal teeth numbers and the ratio of et-est/est-dsb. It was established that the European and Anatolian populations had similar features and *Euscorpius italicus awhasicus* was not a valid subspecies.

Keywords: Distribution, Systematics, *Euscorpius italicus*, *Polytrichobothrius*, Euscorpiidae, Scorpiones, Turkey.

Introduction

The scorpion genus *Euscorpius* Thorell, 1876 of Family Euscorpiidae is widely distributed across the Western Palaearctic. Its range includes North Africa and south and central Europe, the Balkans and throughout Turkey to the Caucasus (Fet & Sissom, 2000). This genus consists of more than 15 species divided into four subgenera: *Alpiscorpius*, *Euscorpius*, *Polytrichobothrius*, and *Tetratrichobothrius*. *Polytrichobothrius* Birula, 1917, consists of two species (Fet *et al.*, 2004). *Euscorpius italicus* (Herbst, 1800) has a naturally disjunctive geographic distribution divided in two unequal parts: it is found in southern Europe (mainly in Italy, Slovenia, Croatia, Montenegro, Albania, and north-western Greece) and in a narrow coastal strip along the Black Sea coast of northern Turkey from İstanbul in the west to Georgia and Southern Russia in the east (Krasnodar Region) (Fet & Sissom, 2000; Fet & Kovařík, 2003). *Euscorpius italicus* was also found by Nordmann in the Caucasus on the shores of the Black Sea. Later Nordmann called this species *Scorpio awhasicus*, regarding it as a

"species not yet described". Kessler mentioned this species under the name *Scorpio awhasicus* but defined its relation to *Scorpio italicus* (Herbst) (Birula, 1917a).

Until now *E. italicus* has been named as *E. i. awhasicus* (Nordmann, 1840) several times by Birula (1917a, 1917b), Vachon (1951), Tolunay (1959), Kinzelbach (1985), Crucitti (1999) from Tekirdağ, Kocaeli, Ordu, Giresun, Rize, Trabzon on the Northern Coastal Region and from Çorum (Kargı) on the inner parts of Turkey. In these studies, the Anatolian, as well as the Caucasian populations were classified as *E. i. awhasicus*. Birula (1917a) examined the specimens from Caucasus, Italy, Anatolia and the Balkans and stated that they did not differ from each other in any feature (number of pectinal teeth and ventral trichobothria of pedipalp, patella and chela), and that the Caucasian form could not be separated from the type specimens even as a local race. He suggested that *Scorpius naupliensis* C.L.Koch, 1842 should be considered as a local race of the species because of its fine granulation of the patella. Vachon (1981) studied the specimens from Italy, Switzerland, Greece and Turkey (İstanbul, n = 1) and listed all forms of the species as synonyms but noted that the different trichobothrial features of the Peloponnesian specimens. Kinzelbach (1975), who had previously synonymized all known subspecies to the nominated subspecies, later suggested *E. i. awhasicus* to be a valid subspecies (Kinzelbach, 1985). Bonacina (1982) showed the overall variations in the number of ventral chelal and patellar trichobothria of the Italian specimens. Currently no valid subspecies of *E. italicus* are recognized (Fet & Sissom, 2000). Gantenbein *et al.* (2002) who elevated *Euscorpius naupliensis* (C.L.Koch, 1837) to species status, examined six specimens of *E. italicus* from Turkey and classified the Turkish samples of *E. italicus* together with the European specimens. Fet *et al.* (in press) demonstrated an extremely low genetic divergence across the geographic range (Switzerland, Italy, Greece, Turkey, and Slovenia) of the species.

The distribution of *E. italicus* in Turkey along Black Sea Coast is less well documented. Only a few coastal sites are known between İstanbul and Rize and several taxonomic problems remain unresolved concerning the status of some Italian, Greek, Turkish and Caucasian populations (Gantenbein *et al.*, 2002).

In this study, the Turkish populations of *E. italicus* were studied for the first time with respect to meristic morphological features (number of patellar ventral and external trichobothria, chelal ventral trichobothria, pectinal teeth counts and ratio of et-est / dsb) and the new distributional records of *E. italicus* from Turkey are presented including one record in Kars Province in north-eastern part of the country, which has a naturally disjunctive distribution. Results only belong to material examined were given in tables and distributional records were plotted on a map.

Populations outside the main geographic range are assumed to have been introduced by human beings (Gantenbein *et al.*, 2002). Such populations of *E. italicus* have also been reported from other places closer to the main range of the species, but still disjunctive: Yemen (Birula, 1937), south-western Romania (Vachon, 1981); and Switzerland (Braunwalder, 2001), and Iraq (Fet & Kovařík, 2003).

This paper aims to elucidate the systematic status of *E. italicus* and to present data on the distribution of this species in Turkey. In addition, some data on the biology of this species in the eastern part of its distributional range is provided.

Material and Methods

A total of 260 specimens of *E. italicus*: 77 ♀♀, 79 ♂♂ adults, 7 subadults, 20 and 11 juveniles completed the first instar, and 28, 29 and 9 newborn embryos were collected from different localities in northern Turkey between 1998 and 2005 (Fig. 1). I also

examined 156 adult specimens of *E. italicus* for trichobotrial features, pectinal teeth numbers and the ratio of et-est / est-dsb.

Measurements were taken with a stereomicroscope (Olympus SZX9) equipped with a micrometric ocular piece (0.1 mm accuracy). Trichobothrial scores were taken according to the standard convention (Gantenbein *et al.*, 2002). The nomenclature used follows that of Vachon (1981), Bonacina (1982) and Gantenbein *et al.* (2002).

All specimens are preserved in 75% alcohol at the Department of Biology, Niğde University (ZDNU).

Abbreviations

Dp: Number of pectinal teeth.

Chela Ventral: Number of trichobothria on the ventral, ventroexternal carina and external aspect of pedipalp chela.

Tv: Number of trichobothria on the ventral aspect of pedipalp patella.

Te: The number of trichobothria on the external aspect including et, est, em, esb_a, esb, eb_a, eb, **(et**: terminal; **est**: subterminal; **em**: median; **esb_a**: suprabasal "a"; **esb**: suprabasal; **eb_a**: basal "a"; **eb**: basal).

et-est/est-dsb: The ratio of the distance between the trichobothria et (external terminal)-est (external subterminal) and est (external subterminal)-dsb (dorsal suprabasal) on the fixed finger of pedipalp chela.

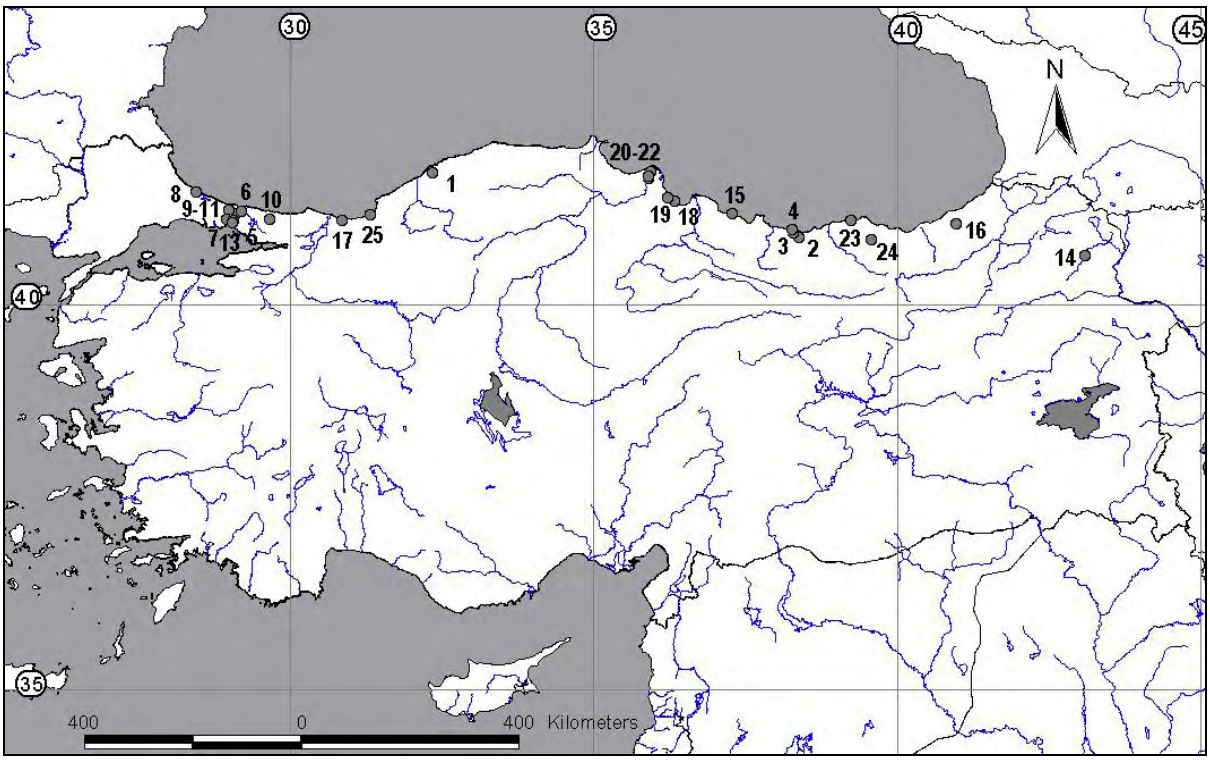


Fig. 1. Localities of examined material of *Euscorpius italicus* (Herbst, 1800). Explanation in text.

Results

Material examined: – *Bartın*: Amasra (centre) [***1a***], 03.XI.2003: 1♀ (2003/186), Amasra Castle [***1b***], 04.XI.2003: 1 ♂ (2003/230). – *Giresun*: Kemaliye Köyü [***2***], 20.VIII.2001: 1♂ (2001/86); Bulancak, İnece Village, Davutlu Quarter [***3***], 01.VIII.2003:

1♂, 1♀ (2003/32.1-2), 25.VII.2004: 1♀, 2♂♂, (2004/62.1-3), Samugüney Village [***4***], 20.II.1996: 1♀, 2♂♂ (1996/41.1-3), 21.II.1996: 4♂♂, 2♀♀ (1996/184), 20.VIII.2001: 1♂ (2001/86), 30.VIII.2001: 1♀ (2001/50), 01.III.2002: 1♂ (2002/1), 02.VIII.2003: 1♀, 1♂ (2003/21.1-2). – *İstanbul* [***11a***], 25.XI.2002: 5♂♂, 3♀♀ (2002/74.1-8), 23.X.2005: 2♀♀, 2♂♂ (2005/100.1-4); Beykoz [***5***], -.VII.2001: 1♀ (2001/121), 15.XI.1996: 1♀ (1996/48), 30.IX.2003: 1♂ (2003/42), Arnavutköy [***6***], 15.VIII.1997: 3♀♀ (1997/19.1-3), Çengelköy, Military Buildings [***7***], 18.VIII.2001: 1♂ (2001/30); Çatalca, Ormanlı Village [***8***], 07.IX.2003: 1♂ (2003/1); Sarıyer, Bahçeköy [***9***], -.VIII.2004 1 ♀ (2004/34); Şile, Tekeköy [***10***], 10.VIII.2004: 1♂ (2004/71); Şişli [***11b***], 07.XI.2005: 1♂ (2005/109); Üsküdar, Çamlıca [***12***], 15.VIII.2003: 1♂ (2003/191), 20.I.2004: 1♂ (2004/23), 04.VII.2003: 1♀, 3♂♂ (2003/190.1-4), Kısıklı, Çakaldağ Village [***13***], 08.V.2005: 1♀ (2005/9). – *Kars*: centrum, near Faculty of Science-Arts and Kars Castle [***14***], 15.IV.2002: 1♀, 1♂ (2002/118.1-2). – *Ordu*: Ünye [***15a***], 11.IX.2002: 1♀, 2♂♂ (2002/124.1-3), Çınarlık Quarter [***15b***], 1♂ (2004/01). – *Rize*: Çamlıhemşin, Şenyuva-Ülkü villages [***16***], 20.VIII.2003: 2♂♂ (2003/134.1-2). – *Sakarya*: Kocaali, Dere Quarter [***17***], 12.VIII.2002: 1♂ (2002/44). – *Samsun*: Fatih Quarter [***18a***], 20.VIII.2003: 2♀♀, 1♂ (2003/35.1-3), 14.VII.2002: 2♂♂ (2002/69.1-2), Kadıköy Quarter [***18b***], 13.IX.2003: 1♀, 1♂ (2003/36.1-2), Alanlı Village [***19a***], 27.VIII.2003: 5♀♀, 2♂♂ (2003/40.1-7), between Alanlı-Birkut Villages [***19b***], 27.VIII.2003: 2♀♀, 1♂ (2003/39.1-3); Bafra (centre) [***20a***], 17.VII.2005: 5♀♀, 6♂♂ (2005/104.1-11); 23.VIII.2005: 13♀♀, 8♂♂ (2005/66.1-21), Yaka Quarter [***20b***], 02.VII.2005: 9♀♀, 9♂♂ (2005/101.1-18), Karpuzlu Village [***21***], 24.VIII.2005: 7♀♀, 5♂♂ (2005/102.1-12), Koşu Village [***22***], 26.VIII.2005: 6♀♀, 6♂♂ (2005/103.1-12). – *Trabzon*: Beşikdüzü [***23***], 06.VIII.2003: 1♂ (2003/140); Maçka, Ocaklı Village [***24***], 06.VII.2005: 1♀ (2005/42). – *Zonguldak*: Alaplı, Kocaman Forest Station [***25***], 01.XII.2004: 1♀, 1♂ (2004/72.1-2).

Morphology: In females, pectinal teeth number varied between 8 and 10. The number of pectinal teeth according to the counted pectines of 77 females were as follows: 8-8 (in 30 specimens or 39%), 9-9 (21 or 27.3%), 8-9 (10 or 13%), 9-8 (9 or 11.7%), 7-8 and 8-10 (2 or 2.6%), 5-9, 9-10 and 7-7 (1 or 1.3%).

In males, pectinal teeth number varied between 9 and 12. The number of pectinal teeth according to the counted pectines of 79 males were as follows: 10-10 (in 46 specimens or 59%), 10-11 (13 or 16.7%), 11-11 (9 or 11.5%), 9-10 (7 or 9%), 11-12 (2 or 2.6%), 9-9 and 10-12 (1 or 1.3%).

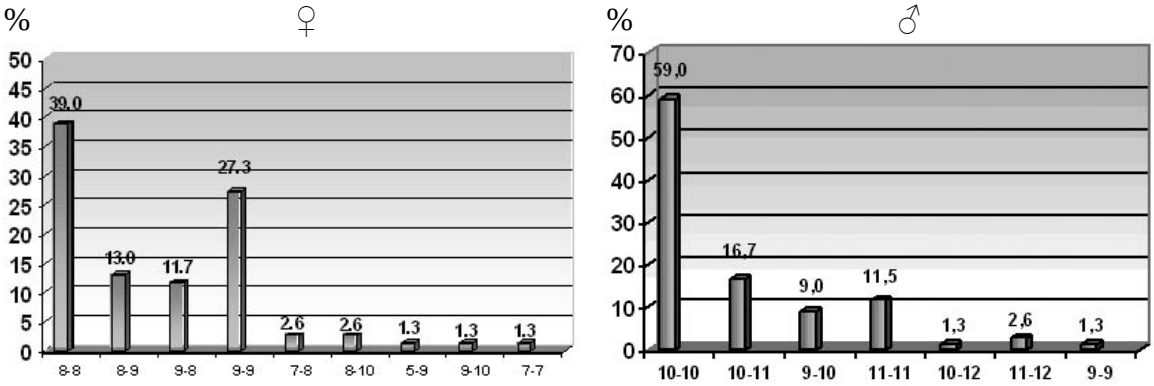


Fig. 2. Percentage of pectinal teeth counts of 77 females and 79 males of *Euscorpius italicus* (Herbst, 1800).

Based on the 312 samples scored, in the pedipalp patella the number of eb, eb_a, em and est trichobothria did not show much variation. These numbers were generally fixed at certain characteristic values. For instance, although the eb series varied between 3 to 5, predominantly eb was equal to 4 (296 specimens or 94.9% of 312 samples). The same was valid also for eb_a. It varied between 4 and 7 but predominantly the eb_a value was 6 (295 specimens or 94.6%). The em series varied between 3 to 6, but predominantly em was 5 (303 specimens or 97.1%). Finally est varied between 3 to 5, and predominantly est was 4 (306 specimens or 98.1%).

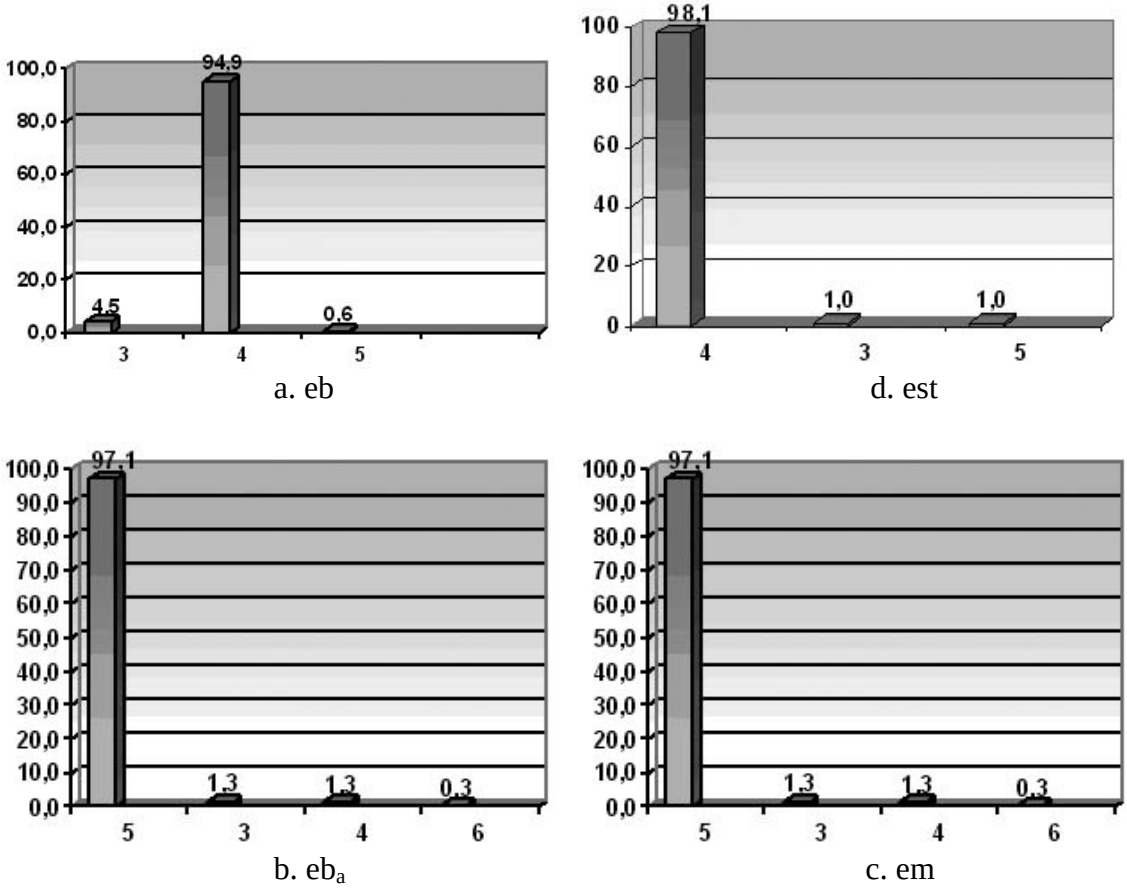


Fig. 3. Statistical data for pedipalp patella trichobothrial counts of *Euscorpius italicus* (Herbst, 1800). a: eb = external basal, b: eb_a = external basal "a", c: em = external median, d: est = external subterminal (number above each column refers to percentage value in total number of patellae).

As a result of examination of a total of 312 patellae belonging to 156 specimens, the number of ventral patellar trichobothria varied from 9 to 14; 188 patellae (60.3%) of scored pedipalps had 12 trichobothria, 70 patellae (22.4%) had 13 trichobothria and 42 patellae (13.5%) had 11 trichobothria. The rest of the trichobothria categories were found with relatively lower frequencies. Only 2 patellae (0.6%) had 9 trichobothria, 3 patellae (1%) had 10 trichobothria, and 7 patellae (2.2%) had 14 trichobothria.

Number of esb_a trichobothria in the external patellar series varied from 4 to 11; 130 patellae (41.7%) of the scored patellae had 7 trichobothria, 82 patellae (26.3%) had 8 trichobothria, 41 patellae (13.1%) had 6 trichobothria, and 37 patellae (11.9%) had 9 trichobothria. Four categories had frequencies lower than 5%; 13 patellae (4.2%) had 10

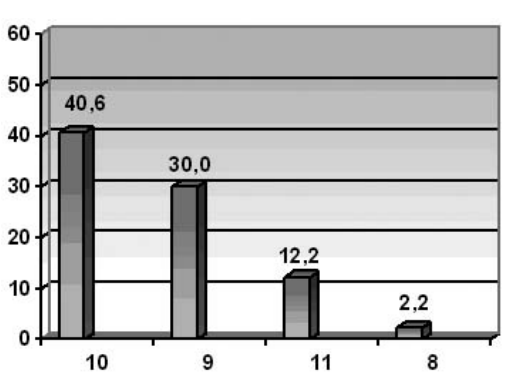
trichobothria, 7 patellae (2.2%) had 5 trichobothria, and finally there was one patella (0.3%) with 4 trichobothria and another with 11 trichobothria.

The number of et trichobothria in the external patellar series varied from 4 to 9; 218 patellae (69.9%) had 7 trichobothria, 55 patellae (17.6%) had 8 trichobothria, 35 patellae (11.2%) had 6 trichobothria and only 2 patellae (0.6%) had 4 trichobothria, one patella (0.3%) with 5 trichobothria and another with 9 trichobothria. Variability and statistical distribution of pedipalp trichobothria are shown in Figs. (3-4).

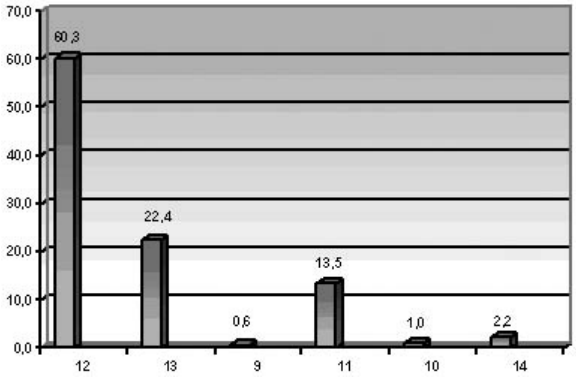
In our analysis of 156 specimens, the number of ventral trichobothria of chela ranged between 8 and 11. Ventral trichobothria of chela are located on both the ventral and external aspect of the manus. In most specimens, one trichobothrium is found on the ventroexternal carina (rarely 2 or 3). For 156 samples, 18 different configurations were determined in terms of the numbers found on the external, ventro-external carina and ventral surface of the manus. The percentage of 98.59% of these samples exhibited trichobothria situated on the ventro-external carina and on the external surface, 85.44% had one, and 7.51% had two trichobothria.

The following seven configurations were dominant accounting for 82.71% of the samples: (external + ventro-external carina + ventral)

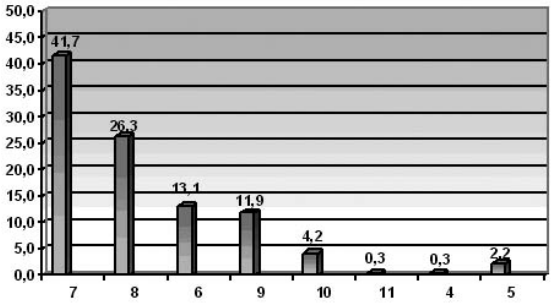
1+1+8 = 10,	30.98%	1+2+8 = 11,	5.12%	2+1+8 = 11,	2.81%
1+1+7 = 9,	25.75%	0+2+7 = 9,	4.22%		
1+2+7 = 10,	9.61%	1+1+9 = 11,	4.22%		



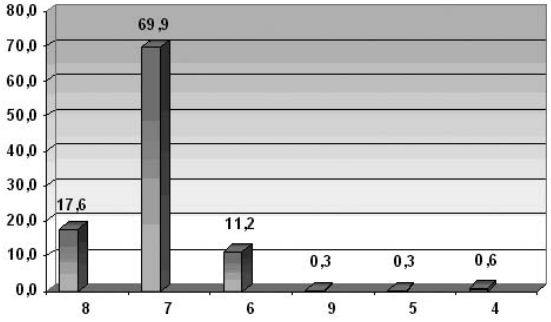
a. Chela ventral



b. Patella ventral



c. esb_a

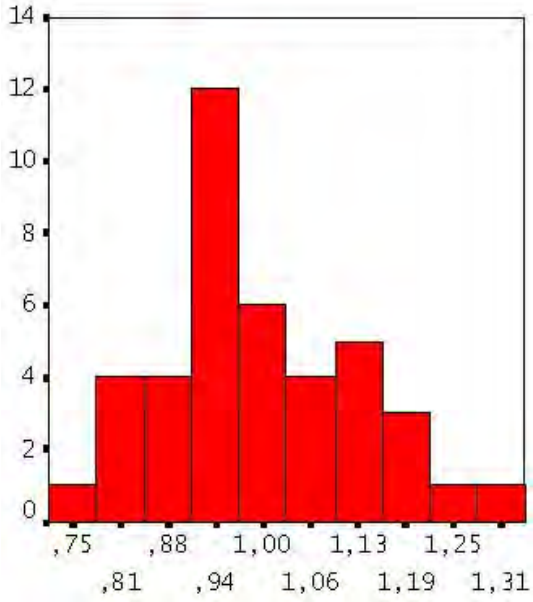


d. et

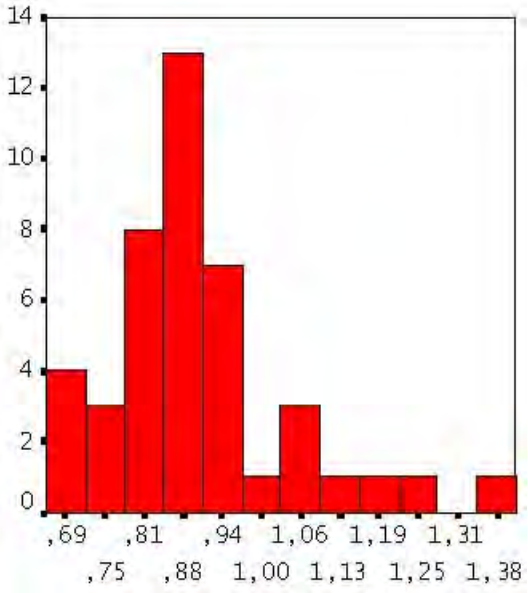
Fig. 4. Statistical data for pedipalp patella trichobothrial counts of *Euscorpius italicus* (Herbst, 1800). a: chela ventral, b: patella ventral, c: esb_a = external suprabasal "a", d: et = external terminal (number above each column refers to percentage value in total number of patellae).

A total of 41 females and 43 males were measured to determine whether or not the ratio of et-est/est-dsb reflected a difference between European and Turkish populations of *E. italicus*. The mean value of the ratio of chelal fixed finger trichobothria et-est/est-dsb was determined to be 0.99±0.12 (Range: 0.77-1.30) for females and 0.89±0.13 (Range: 0.66-1.35) for males.

The new distributional record of *E. italicus* from Turkey was given from Kars Province in north-eastern part of the country, which has a naturally disjunctive distribution. But the specimens from Kars Province (one male and one female) (2002/118.1-2) had no morphometric differences from the other specimens from Turkey. Trichobothrial formulae (chela ventral, patella ventral, eb, eb_a, esb, esb_a, em, est, et) of female (2002/118.1) 11-10, 12-12, 44, 66, 22, 77, 55, 44, 77; the same of male (2002/118.2) 9-10, 12-12, 44, 66, 22, 76, 55, 44, 46. The pectinal teeth number of female was 8-8 and for male it was 10-10.



Female
Std. Dev. = 0.13, Mean = 1.00, N = 41.00



Male
Std. Dev. = 0.14, Mean = 0.89, N = 43.00

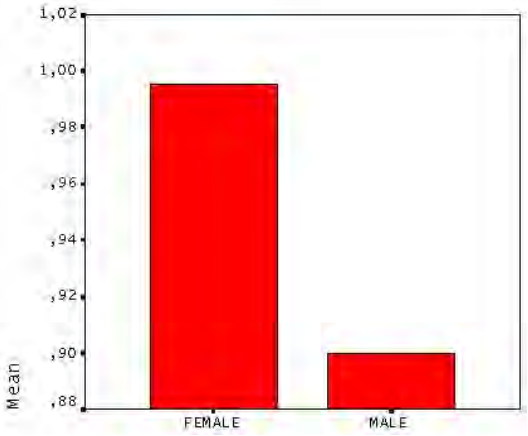


Fig. 5. The ratio of et – est / est – dsb trichobotria.

Discussion

The statistical data on pectinal teeth and trichobothria from the Turkish specimens fall within the limits of those known for *E. italicus* that were indicated by Gantenbein *et al.* (2002).

As a result of the statistical analysis of *E. italicus* populations from Turkey, only differences in the number of esb_a series were determined in comparison with the European populations. Gantenbein *et al.* (2002) indicated that the number of esb_a series for European populations was predominantly 9 but in Turkish populations this number is predominantly 7. The numbers of all other trichobothria showed similar values.

Gantenbein *et al.* (2002) denoted that this ratio in European population of *E. italicus* for females as 0.983±0.085 (Range: 0.83-1.15), for males as 0.825±0.111 (Range: 0.69-1.07). My results conform that of European population indicated by Gantenbein *et al.* (2002).

According to the diagnostic criteria given by Gantenbein *et al.* (2002), especially the trichobothrial numbers and patterns, and ratio of et-est/est-dsb, it is clear that the Turkish populations of *E. italicus* belong to the nominotypic form. This supports the notion that *E. i. awhasicus* is not a valid subspecies, as stated by Fet & Sissom (2000) and Gantenbein *et al.* (2002).

In Kars province, the presence of two adult specimens indicated a reproducing population and this population has been introduced by human beings. The closest known populations of *E. italicus* are those in Artvin and Rize in Eastern Karadeniz Region, which is the likely source of introduction.

My data shows a wide variation in the number of ventral and chelal trichobothria of *E. italicus* in Turkey and provided distribution records from Turkey. This also provides some data on the biology of this species at the eastern part of its distributional range.

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Cave dwelling spiders (Araneae) of Turkey

Aydın Topçu, Hakan Demir and Osman Seyyar
Department of Biology, Faculty of Science and Arts, University of Niğde,
TR-51200, Niğde, Turkey
Corresponding e-mail: hakandemir@gazi.edu.tr

Abstract

In this study, a faunistic list of 61 species of cave dwelling spiders of Turkey has been constructed depending on previous literature records of the spider fauna of Turkey.

Keywords: Spiders, Araneae, Caves, Turkey.

Introduction

The geological differences and formations of Turkey have contributed its bio-variety at an important rate. According to the data of M.T.A. (Directorate of the Institute of Mineral Research), the caves, covering 2/5 of Turkey, also nestle many species of spiders that had settled underground during the previous geologic ages and insulated from the outside for a long time.

Cave dwelling spiders, as zoogeographic agents, are important for biospeleology (Brignoli, 1979). The first study on fauna of cave dwelling spiders of Turkey belongs to the French biospeleologist Fage (1931), who revised cave dwelling spiders and described *Palliduphantes byzantinus* (Linyphiidae) as a new species dwelling in Yarımburgaz cave in İstanbul.

Roewer (1959) had a detailed study on arachnids collected from Greece, Crete, Anatolia, Iran and India by Dr. Kunt Lindberg. In his study, Roewer recorded 37 species belonging to 17 families from the caves of Turkey. In another study, Roewer (1962) described *Hoplopholcus patrizii* (Pholcidae) as a new species and recorded *Pachygnatha degeeri* (Tetragnathidae) from a cave in Antalya. Wiehle (1963) collected only one specimen of *Carpathonesticus borutzkyi* to record it from Turkey.

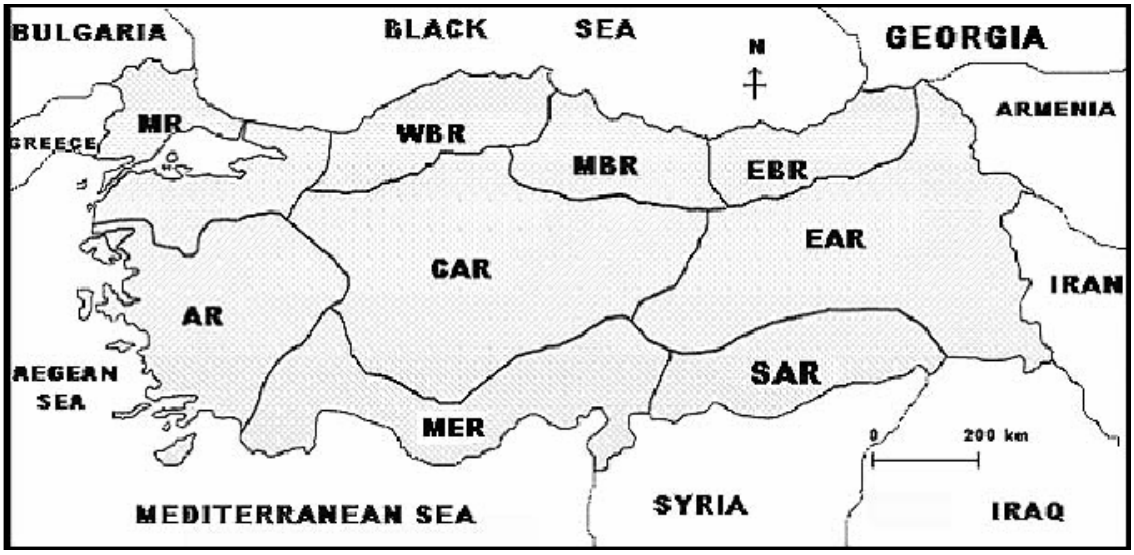
In her study called "Turkish Spiders. I. Preliminary List", Karol (1967) talked about cave dwelling spiders recorded by different arachnologists and attributed to the authors of these records.

Aygen (1971) and Başar (1971) mentioned records from some caves of different Turkish cities. They only talked about morphological and behavioural features of the spiders but they did not inform about the species of the spiders.

Brignoli (1968, 1971, 1972, 1978a, 1978b, and 1979) gave broad information about systematical and biogeographical features of cave dwelling spiders of Europe, Aegean Islands and Turkey. He recorded 18 spider species that belong to different families from the caves of Turkey and described them as new to science.

Deeleman-Reinhold & Deeleman (1988) recorded 4 species belonging to family Dysderidae from the caves of Turkey, including *Dysderocrates regina* as new species.

Deltshev (1972-1995, in Platnick, 2006) studied cave dwelling spiders of the Balkans and Aegean Islands. Deltshev (1996, 2000) stated that endemic spiders in Balkans often dwell high mountain peaks and caves. He claimed in his studies that some endemic spiders of the Balkans might be related to the North part of Turkey.



Map 1. Geographical regions of Turkey. WBR = West Black Sea Region, MBR = Middle Black Sea Region, EBR = East Black Sea Region, MR = Marmara Region, AR = Aegean Region, MER = Mediterranean Region, CAR = Central Anatolia Region, EAR = East Anatolia Region, and SAR = Southeast Anatolia Region.
[WBR: Zonguldak; MR: Bursa, İstanbul, Yalova; MER: Adana, Antalya, Burdur, Hatay, Isparta, Kahramanmaraş, Mersin; CAR: Karaman, Kayseri, Konya; EAR: Bitlis, Diyarbakır, Elazığ; SAR: Gaziantep, Mardin.]

Results and Discussion

Family Theraphosidae Thorell, 1870

Chaetopelma gracile (Ausserer, 1871)

Distribution in Turkey: Kahramanmaraş, Güvercinlik, Lor Cave (Roewer, 1959).

Family Filistatidae Ausserer, 1867

Filistata insidiatrix (Forskål, 1775)

Distribution in Turkey: Hatay, Antakya, Suadiye, Mağaracık (Roewer, 1959).

Family Sicariidae Keyserling, 1880

Loxosceles rufescens (Dufour, 1820)

Distribution in Turkey: Kahramanmaraş, Elbistan, Culundu Cave (Roewer, 1959).

Family Leptonetidae Simon, 1890

Cataleptoneta aesculapii (Brignoli, 1968)

Distribution in Turkey: Antalya, Alanya, Damlataş Cave (Brignoli, 1968, 1978).

Cataleptoneta sbordonii (Brignoli, 1968)
Distribution in Turkey: Burdur, İnsuyu Cave (Brignoli, 1968, 1978); Antalya, Döşemealtı, Yağca Village, Mustanini Cave (Brignoli, 1978).

Family Pholcidae C.L. Koch, 1851
Holocnemus pluchei (Scopoli, 1763)
Distribution in Turkey: Elazığ, Harput, Buzluk Cave; Kahramanmaraş, Güvercinlik, Lor Cave (Roewer, 1959).
Hoplopholcus patrizii (Roewer, 1962)
Distribution in Turkey: Antalya, Dağ Cave (Roewer, 1962); Antalya, Döşemealtı, Karain Cave (Brignoli, 1972).
Pholcus opilionoides (Schrank, 1781)
Distribution in Turkey: Bursa, İnkaya Village, Suini Cave (Roewer, 1959).
Pholcus phalangioides (Fuesslin, 1775)
Distribution in Turkey: Hatay, Samandağ, Mağaracık, Büyük Cave; Diyarbakır, Lice, Korkha Cave (Roewer, 1959).
Pholcus spasskyi Brignoli, 1978
Distribution in Turkey: Diyarbakır, Lice, Korkha Cave (Brignoli, 1972).

Family Dysderidae C.L. Koch, 1837
Dysdera crocata C.L. Koch, 1838
Distribution in Turkey: Hatay, Antakya, Narlıca Cave (Roewer, 1959; Deeleman-Reinhold & Deeleman, 1988).
Dysdera hamulata Kulczyński, 1897
Distribution in Turkey: Hatay, Antakya, Narlıca Cave; Mardin, A Cave near Mardin (Deeleman-Reinhold & Deeleman, 1988).
Dysderocrates regina Deeleman-Reinhold, 1988
Distribution in Turkey: Antalya, Akseki, Altınbeşik-Düdensuyu Cave; Konya, Gerikini Cave (Deeleman-Reinhold & Deeleman, 1988).
Harpactea agnolettii Brignoli, 1978
Distribution in Turkey: Isparta; İnönü Cave (Brignoli, 1978).
Harpactea pisidica Brignoli, 1978
Distribution in Turkey: Isparta, Eğirdir, a cave near Anamas (Brignoli, 1978).
Harpactea sanctaeinsulae Brignoli, 1978
Distribution in Turkey: Konya, Beyşehir Gölü, Hacı Akif Adası, Hacı Akif Cave (Brignoli, 1978).
Harpactocrates troglophilus Brignoli, 1978
Distribution in Turkey: Isparta, Anamas, Zindan Cave (Brignoli, 1978).
Hygrocrates lycaoniae (Brignoli, 1978)
Distribution in Turkey: Konya, Çamlık, Körükini Cave (Deeleman-Reinhold & Deeleman, 1988).

Family Uloboridae Thorell, 1869
Uloborus plumipes Lucas, 1846
Distribution in Turkey: Hatay, Antakya, Narlıca Cave (Roewer, 1959).

Family Nesticidae Simon, 1894
Carpathonesticus borutzkyi Reimoser, 1930
Distribution in Turkey: Zonguldak, Ereğli, a cave near Ereğli (Wiehle, 1963); Zonguldak, Kapuz Cave (Brignoli, 1972).
Nesticus cellulanus (Clerck, 1757)
Distribution in Turkey: Hatay, Antakya, Narlıca Cave; Zonguldak, Ereğli, Ilıksu Cave; Elazığ, Harput, Buzluk Cave; Bitlis, Ahlat, Sultan Seyit Cave (Roewer, 1959).

Family Theridiidae Sundevall, 1833

Latrodectus pallidus O.P.-Cambridge, 1872

Distribution in Turkey: Kahramanmaraş, Afşin, Guezeu Cave (Roewer, 1959).

Family Linyphiidae Blackwall, 1859

Centromerus unicolor Roewer, 1959

Distribution in Turkey: Hatay, Antakya, Narlıca Cave (Roewer, 1959).

Diplocephalus turcicus Brignoli, 1972

Distribution in Turkey: Burdur, İnsuyu Cave; Isparta, Anamas, Zindan Cave; Konya, Beyşehir Gölü, Hacı Akif Adası, Hacı Akif Cave (Brignoli, 1972).

Gongylidium rufipes (Linnaeus, 1758)

Distribution in Turkey: Hatay, Antakya, Narlıca Cave (Roewer, 1959).

Lepthyphantes leprosus (Ohlert, 1865)

Distribution in Turkey: Diyarbakır, Lice, Korkha Cave; Bitlis, Ahlat, Sultan Seyit Cave (Roewer, 1959).

Megalepthyphantes collinus (L. Koch, 1872)

Distribution in Turkey: Elazığ, Harput, Buzluk Cave; Bitlis, Ahlat, Sultan Seyit Cave; Bitlis, Adilcevaz, Kon Cave (Roewer, 1959).

Palliduphantes byzantinus (Fage, 1931)

Distribution in Turkey: İstanbul, Yarım Burgaz Cave (Fage, 1931); Bitlis, Adilcevaz, Kon Cave (Roewer, 1959).

Troglohyphantes pisidicus Brignoli, 1971

Distribution in Turkey: Konya, Beyşehir Gölü, Hacı Akif Adası, Hacı Akif Cave (Brignoli, 1971).

Family Tetragnathidae Menge, 1866

Meta bourneti Simon, 1922

Distribution in Turkey: Yalova, I. ve II. Soğucak Cave; Bursa, İnkaya Village, Suini Cave (Roewer, 1959).

Metellina merianae (Scopoli, 1763)

Distribution in Turkey: Bursa, Ayvaini Cave; Hatay, Antakya, Narlıca Cave (Roewer, 1959).

Pachygnatha degeeri Sundevall, 1830

Distribution in Turkey: Antalya, Dağ Cave (Roewer, 1962).

Family Lycosidae Sundevall, 1833

Hogna radiata (Latreille, 1817)

Distribution in Turkey: Yalova, Soğucak Village, V. Soğucak Cave (Roewer, 1959).

Pardosa agricola (Thorell, 1856)

Distribution in Turkey: Gaziantep, Arapdede Cave (Roewer, 1959).

Trochosa terricola Thorell, 1856

Distribution in Turkey: Bursa, İnkaya Village, Kuşini Cave (Roewer, 1959).

Family Agelenidae C.L. Koch, 1837

Agelena labyrinthica (Clerck, 1757)

Distribution in Turkey: Mardin, Midyat, Derömer Cave (Roewer, 1959).

Agelescape affinis (Kulczyński, 1911)

Distribution in Turkey: Hatay, Harbiye, Büyük Cave; Bitlis, Ahlat, Sultan Seyit Cave (Roewer, 1959).

Tegenaria agnolettii Brignoli, 1978

Distribution in Turkey: Antalya, Döşemealtı, Mustanini Cave (Brignoli, 1978).

Tegenaria anhela Brignoli, 1972
Distribution in Turkey: Antalya, Döşemealtı, Karain Cave (Brignoli, 1972, 1978).
Tegenaria atrica C.L. Koch, 1843
Distribution in Turkey: Kayseri, Araplı, Harmankaya Cave (Roewer, 1959).
Tegenaria averni Brignoli, 1978
Distribution in Turkey: Mersin, Silifke, Cennet Cave (Brignoli, 1978).
Tegenaria domestica (Clerck, 1757)
Distribution in Turkey: Hatay, Antakya, Narlıca Cave (Roewer, 1959).
Tegenaria elysii Brignoli, 1978
Distribution in Turkey: Mersin, Silifke, Dilek Cave; Mersin, Silifke, Cennet Cave (Brignoli, 1978).
Tegenaria faniapollinis Brignoli, 1978
Distribution in Turkey: Hatay, Harbiye, Harbiye Cave (Brignoli, 1978).
Tegenaria ferruginea (Panzer, 1804)
Distribution in Turkey: Bursa, İnkaya Village, Suini Cave (Roewer, 1959).
Tegenaria forestieroi Brignoli, 1978
Distribution in Turkey: Karaman, Taşkale, Asarini Cave; Isparta, İnönü Cave; Antalya, Akseki, Dikmen Cave; Konya, Seydişehir, Ferzen Cave; Konya, Seydişehir, Tınaztepe Cave; Konya, Çamlık, Körükini Cave; Konya, Hadim, Suçıktığı Cave (Brignoli, 1978).
Tegenaria karaman Brignoli, 1978
Distribution in Turkey: Konya, Seydişehir, Ferzen Cave (Brignoli, 1978).
Tegenaria melbae Brignoli, 1972
Distribution in Turkey: Diyarbakır, Lice, Korkha Cave (Roewer, 1959).
Tegenaria pagana C.L. Koch, 1840
Distribution in Turkey: Hatay, Antakya, Narlıca Cave; Diyarbakır, Lice, Korkha Cave (Roewer, 1959).
Tegenaria percuriosa Brignoli, 1972
Distribution in Turkey: Isparta, Anamas, Zindan Cave (Brignoli, 1972, 1978); Isparta, Barla, Barla Cave (Brignoli, 1978); Konya, Beyşehir Lake, Hacı Akif Island, Hacı Akif Cave (Brignoli, 1978).

Family Amaurobiidae Thorell, 1870
Coelotes atropos (Walckenaer, 1830)
Distribution in Turkey: Zonguldak, Ereğli, a cave in Ova Village (Roewer, 1959).
Coelotes terrestris (Wider, 1834)
Distribution in Turkey: Bursa, İnkaya Village, Suini Cave (Roewer, 1959).

Family Phyxelididae Lehtinen, 1967
Phyxelida anatolica Griswold, 1990
Distribution in Turkey: Hatay, Samandağ, Mağaracık, Büyük Cave (Roewer, 1959).

Family Gnaphosidae Pocock, 1898
Drassodes lutescens (C. L. Koch, 1839)
Distribution in Turkey: Kahramanmaraş, Alikaya Cave (Roewer, 1959).

Family Sparassidae Bertkau, 1872
Eusparassus dufouri Simon, 1932
Distribution in Turkey: Adana, Haruniye, Sepulcrale Cave (Roewer, 1959).
Heteropoda variegata (Simon, 1874)
Distribution in Turkey: Adana, Pozantı, Şekerpınar, Akköprü Cave (Roewer, 1959).

Family Philodromidae Thorell, 1870

Philodromus collinus C.L. Koch, 1835

Distribution in Turkey: Bursa, İnkaya Village, Suini Cave; Hatay, Antakya, Narlıca Cave (Roewer, 1959).

Philodromus histrio (Latreille, 1819)

Distribution in Turkey: Bitlis, Adilcevaz, Kon Cave (Roewer, 1959).

Family Thomisidae Sundevall, 1833

Ozyptila rauda Simon, 1875

Distribution in Turkey: Zonguldak, Ereğli, İnsırtı, Ercole Cave (Roewer, 1959).

Xysticus audax (Schrank, 1803)

Distribution in Turkey: Hatay, Antakya, Atik (Roewer, 1959).

Family Salticidae Blackwall, 1841

Carrhotus xanthogramma (Latreille, 1819)

Distribution in Turkey: Hatay, Antakya, Narlıca Cave (Roewer, 1959).

Topçu *et al.* (2005) recorded 613 species of spiders, belonging to 43 families, that reported by different authors up to now from Turkey. Many of the known records are from the West Black Sea Region and Mediterranean region which are covered by karstic formations, involving caves.

Unlike Roewer's publications which contained faunistic records, Brignoli's publications contain zoogeographic comments and are the most important ones of all the existing studies. According to Brignoli, the presence of *Carpathonesticus borutzkyi* Reimoser, 1930 and *Pholcus spasskyi* Brignoli, 1978, indicates the relation between Anatolia and the Caucasian region.

Aegean originated species such as: *Cataleptoneta aesculapii* (Brignoli, 1968), *Cataleptoneta sbordonii* (Brignoli, 1968) and *Hoplopholcus patrizii* (Roewer, 1962) point out the relation of Anatolia with Greece and the presence of family Nesticidae in Mediterrenean Region, of Turkey, points out its relation with the Arabian Peninsula through Lebanon in the past.

Brignoli, in his article called "Terzo contributo alla conoscenza dei ragni cavernicoli di Turchia" (1972), claimed that data in Roewer's publications are suspicious. Thus, a spider specimen collected from the Great Cave in Hatay–Samandağ was misidentified as *Amaurobius fenestralis* (Ström, 1768) by Roewer (1959). This specimen, deposited in Gothenburg Zoology Museum, had been examined during Griswold's revision study (1990) and described as a new species called *Phyxelida anatolica* Griswold, 1990 (Family Phyxelididae).

Among the 61 cave dwelling species, here recorded, *Troglohyphantes pisidicus* Brignoli, 1971 (Linyphiidae), *Cataleptoneta aesculapii* (Brignoli, 1968), *Cataleptoneta sbordonii* (Brignoli, 1968) (Leptonetidae) are troglobiont, with eyes completely disappeared or reduced. These species are endemic like the species of family Agelenidae that recorded from the caves of Turkey and illuminate the zoogeographic past of Turkey.

The number of examined caves on an araneological base are restricted in Turkey. However, cave dwelling spiders are sensitive creatures like other cave organisms. Anthropological effects such as: opening the cave for tourism and pollution in underground water affect cave dwelling spiders like other cave organisms. For example, during our recent studies, we did not encounter the species *Cataleptoneta aesculapii* that was described by the great Italian arachnologist Brignoli (1968) from the Damlataş Cave in Alanya.

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A new record for the Turkish spider fauna: *Oecobius cellariorum* (Dugès, 1836) (Araneae: Oecobiidae)

Rahşen S. Kaya [1]*, İsmail Hakkı Uğurtaş [1] and Abdullah Bayram [2]
[1] Department of Biology, Faculty of Science and Art, Uludağ University, 16059 Nilüfer, Bursa, Turkey
[2] Department of Biology, Faculty of Science and Art, Kırıkkale University, 71450 Yahşihan, Kırıkkale, Turkey
* Corresponding author. E-mail contact: rkaya@uludag.edu.tr

Abstract

The characteristic features and drawings of *Oecobius cellariorum* (Dugès, 1836), which is recorded for the first time from Turkey, are given in this study.

Keywords: *Oecobius cellariorum*, Oecobiidae, Araneae, New record, Turkey.

Introduction

Oecobiid spiders are characterized by the presence of cribellum and calamistrum, in addition to a two-jointed anal tubercle fringed with long and curved hairs. The family Oecobiidae is represented by six genera and 102 species in the world. The genus *Oecobius* includes 79 species, and occurs all over the world (Platnick, 2006). Although most species of *Oecobius* have been collected only in a few localities, the genus is best known by some widespread and synanthropic species (Santos & Gonzaga, 2003). Five species are known from Europe: *Oecobius cellariorum* (Dugès, 1836), *O. navus* Blackwall, 1859, *O. maculatus* Simon, 1870, *O. rhodiensis* Kritscher, 1966 and *O. machadoi* Wunderlich, 1995 (Roberts, 1995; Heimer & Nentwig, 1991; Nentwig *et al.*, 2003; Platnick, 2006). The following species are known from the Middle East: *O. cellariorum*, *O. navus*, *O. maculatus*, *O. affinis* O.P.-Cambridge, 1872, *O. albipunctatus* O.P.-Cambridge, 1872, *O. teliger* O.P.-Cambridge, 1872, *O. trimaculatus* O.P.-Cambridge, 1872, *O. putus* O.P.-Cambridge, 1876, *O. templi* O.P.-Cambridge, 1876, *O. amboseli* Shear & Benoit, 1974, *O. alhoutyae* Wunderlich, 1995, and *O. cambridgei* Wunderlich, 1995 (Platnick, 2006). However, no *Oecobius* species have been recorded in Turkey, so far. Only an unidentified specimen of *Oecobius* is known from the Marmara Region in the list of Turkish spiders (Karol, 1967; Bayram, 2002).

This paper deals with the characteristic features of *Oecobius cellariorum*, and adds a species to the spider fauna of Turkey.

Material and Methods

Two males and eight females of *Oecobius cellariorum* were collected in the campus of Uludağ University. All of them were collected inside buildings. The specimens were preserved in 70% ethanol and deposited in the Zoological Museum of the Department of Biology. The identification was made by means of a Zeiss Stemi SR Stereo microscope using the keys of Roberts (1995), Heimer & Nentwig (1991) and Nentwig *et al.* (2003). The drawings were made by means of a camera lucida attached to the microscope. More confirmation depended on comparisons with descriptions and drawings of Shear (1970, Figs. 3, 4, 13, 28, 48, 49) and Wunderlich (1994, Figs. 17-20).

Results

Family: Oecobiidae Blackwall, 1862
Genus: *Oecobius* Lucas, 1846
Species: *Oecobius cellariorum* (Dugès, 1836)
Synonyms:
Clotho cellariorum Dugès, 1836: Observations sur les aranéides. *Ann. sci. nat., Zool.* (2) **6:** 161 (D).
Oecobius domesticus Lucas, 1846.
Oecobius cellariorum Simon, 1875.
Oecobius texanus Bryant, 1936.
Oecobius shaanxiensis Qiu & Zheng, 1981.
Oecobius shensiensis Qiu, 1981.
Oecobius sinensis Yin & Wang, 1981.

Description (Figs. 1-3)

Measurements, total length of the body: 2-2.1 mm in male, 2.1-2.3 mm in female. In both sexes, carapace is wider than long and more or less circular with the front slightly pointed. Carapace is pale yellow and bordered by a thin black line. Cephalic region is slightly higher. Eyes are closely grouped over a dark spot on the anterior margin. The anterior medians and posterior laterals are dark and have dark ridges. The anterior laterals and posterior medians are light in colour. The posterior medians are irregular in shape. In addition, the anterior median and posterior lateral eyes are clearly larger than the rest (Fig. 1). Clypeus is long and pale yellow. Chelicerae are pale. In the centre of the thoracic region, a dark pattern is present. Sternum is heart shaped, wider than long, and shiny light yellow in colour. Legs are long, light yellow in colour, with some dark annulations, and with many thick spines. An abdominal pattern is present in male and female specimens as illustrated in Fig. (1). Abdomen is oval, rounded at the front and narrowed near the posterior point. Dorsum appears whitish yellow in colour. The cardiac region is dark, and some dark patches are located around it. Male has a slimmer abdomen than female. Venter of the abdomen is yellowish light brown in colour. Epigynum without scapus and wrinkled at anterior and posterior sides (Fig. 2). Male palpal organ is distinctive (Fig. 3).

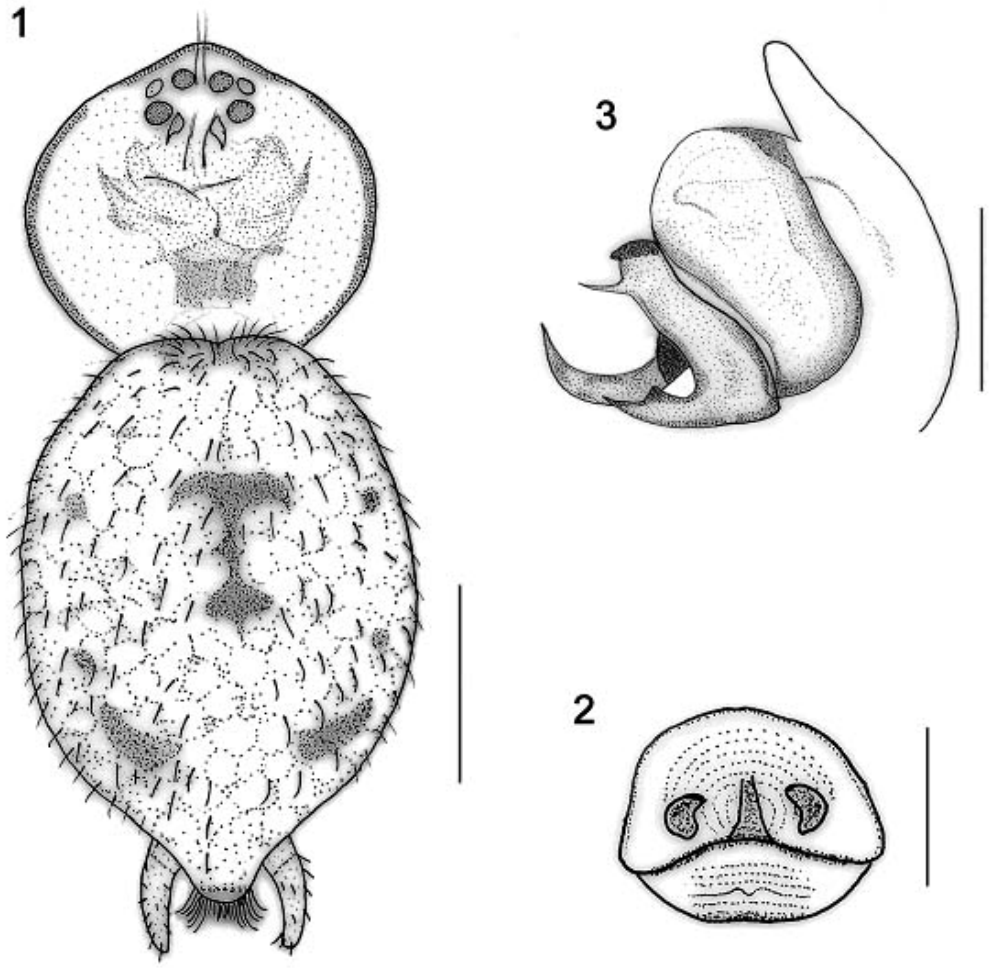
Material Examined

Two males and eight females were collected in the campus of Uludağ University, 107 m, Bursa (40°13′21"N, 28°51′56"E): 3♀♀, 15.08.2004; 2♀♀, 04.08.2005; 2♂♂, 13.08.2005; 3♀♀, 10.09.2005). All specimens were collected inside buildings.

Habitat and distribution

Oecobius cellariorum is common especially in buildings. All specimens were found in the buildings of the campus. This species builds its web on wall corners. The specimens were collected in their circular sheet webs. Star shaped webs are small and about 25-30 mm in diameter. They run very quickly when disturbed.

Oecobius cellariorum is a cosmopolitan, but not a common, species. It had been recorded from some places in the Nearctic, Neotropic, Palearctic, Australasia, and even Antarctic ecozones (Tyschchenko, 1971; Brignoli, 1983; Platnick, 2006).



Figs. 1-3: *Oecobius cellariorum* (Dugès, 1836). 1-2. Female. 1. dorsal view. 2. epigynum. 3. Male palpus, retrolateral view. Scale bars: (1) 0.5 mm, (2-3) 0.25 mm.

Discussion

Male and female specimens are similar in general body shape. Only, male has slimmer abdomen. The colour, design and other characters are similar to those of European specimens (Nentwig *et al*., 2003). However, body sizes of our specimens are slightly smaller than those specimens. In our specimens, the body length is 2-2.1 mm in male, and 2.1-2.3 mm in female, while in European specimens it is 2.2 mm for males, and 2.5-2.9 mm for females. In addition, no significant differences have been determined in genital structures. The palp and epigyne resemble those of European specimens.

In *Oecobius*, 5 species from Europe, and 12 species from the Middle East are known. *O. affinis* and *O. albipunctatus* are known from Syria. Also, 5 species are known from Egypt, i.e. *Oecobius amboseli*, *O. maculatus*, *O. navus*, *O. putus*, and *O. templi* (El-Hennawy, 2004). These species maybe present in Turkey as well but studies on spiders are still new in Turkey. Similarly, *O. navus* is a cosmopolitan species and very common especially in the Palearctic region.

Published articles show that *Oecobius cellariorum* is dependent on buildings (Guarisco, 1999; Santos & Gonzaga, 2003). All of the specimens were found in the buildings in the campus. The buildings are surrounded by some forest trees.

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White widow, *Latrodectus pallidus* (Araneida: Theridiidae), in Jordan and Egypt

Hisham K. El-Hennawy
41 El-Manteqa El-Rabia St., Heliopolis, Cairo 11341, Egypt
E-mail: el_hennawy@hotmail.com

Abstract

The theridiid “White Widow” spider, *Latrodectus pallidus* O.P.-Cambridge, 1872, is recorded from Amman, Jordan and Wadi Kid on Aqaba gulf, southern Sinai, Egypt. It is mainly described from Jericho, Palestine. Its record from Alexandria, Egypt, in 1872, is not true. After excluding doubtful records, the distribution of *L. pallidus* is mainly "Near Eastern and eastern Mediterranean". The westernmost, Cape Verde Is., and southernmost, Yemen, records denote the wide distribution of this species. Other records include Russia, Iran, and Turkey.

The design of the nest of this species is previously described. It was found among vegetation. In this work, the nests (webs) were found among rocks and inside small stony caves. The name "White Widow" is used instead of the current common name of *L. pallidus*, i.e. "Pale widow".

Keywords: Araneida, Theridiidae, *Latrodectus pallidus*, Jordan, Egypt, distribution.

Introduction

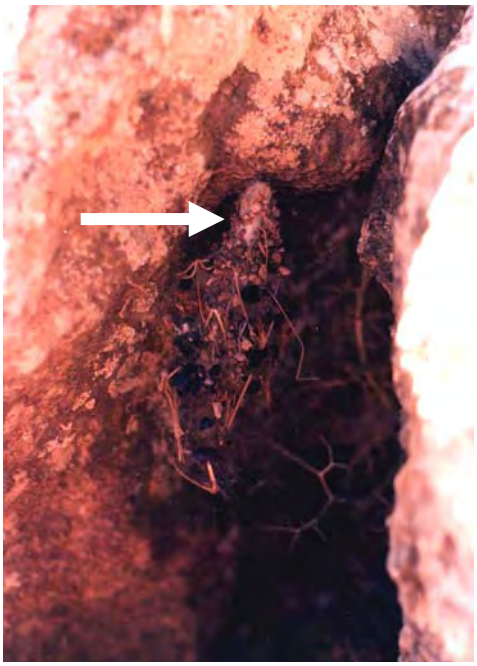
Among the 86 genera (2227 species) of family Theridiidae, genus *Latrodectus* Walckenaer, 1805 includes 31 species distributed in: North Africa, southern Africa and Madagascar; Mediterranean to Southeast Asia, Australia and New Zealand; Asia (Saudi Arabia, Yemen, Socotra, Kuwait, Iran); North and South America; and Spain (southern Europe) (Platnick, 2006).

A female specimen of the theridiid “White Widow” spider, *Latrodectus pallidus* O.P.-Cambridge, 1872 was found near Abu Nusseir, Amman (Jordan) on 1st November 1988 (Fig. 1). Her "nest" was examined and photographed (Fig. 2).

A juvenile theridiid spider was found at the entrance of an empty small stony cave on November 1994 in Kherieza, Wadi Kid, in Nabq protectorate on Aqaba gulf, southern Sinai (El-Hennawy, 2003). It was reared until reaching maturity to be a male *Latrodectus pallidus* (Fig. 3).

The distribution of this species and its web situation are discussed.

1



2

Fig. 1. *Latrodectus pallidus* O.P.-Cambridge, 1872 ♀, found near Abu Nusseir, Amman, Jordan. Fig. 2. Her web "Nest", between two rocks.

The First Record - 1872

The Reverend Octavius Pickard-Cambridge described *Lathrodectus pallidus* as a new species in his "General list of the spiders of Palestine and Syria, with descriptions of numerous new species and characters of two new genera" (1872). He described the female of this species (pp.287-288). The following passages are extracted from his description:

"The colour of the *cephalothorax* is yellow-brown, that of the *palpi* and *legs* yellowish; the tarsi, metatarsi, tibiae, and genua of the latter, as well as the digital joints of the former, being deeply suffused with dark yellow-brown." … "The *abdomen* is of a creamy-white colour with four deep-red-brown spots forming an oblong about the centre of the upper-side; the two foremost spots are smaller and nearer together than the hinder ones." … "Adult and immature females were found in irregular snares spun among low plants on the plains of the Jordan; while the only situation in which *L. erebus* was found was beneath stones. In a similar situation the latter species was also found, not un-frequently, at Alexandria (Egypt) in 1864."

In 1876, Pickard-Cambridge only recorded *L. erebus* from Egypt. Females of this species "were found under stones among the ruins of an old building at Alexandria." He did not mention *L. pallidus*. [Note: *L. erebus* Savigny, 1825 (In: Audouin, 1825 & 1827) = *L. tredecimguttatus* (Rossi, 1790)]

Hence, the distribution of *L. pallidus* began by "the plains of the Jordan" as a new species "of the spiders of Palestine". The type material, 2♀♀, were collected from Jericho (Levy & Amitai, 1983). The hurried reading of the last paragraph of Pickard-Cambridge's description of *L. pallidus* led to the wrong result that it is also found in Egypt (Roewer, 1942; El-Hennawy, 1990 & 2002b).

3

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Fig. 3. *Latrodectus pallidus* O.P.-Cambridge, 1872 ♂, found in Kherieza, Wadi Kid.
Fig. 4. Stony caves of *L. pallidus* in Kherieza, Wadi Kid, in Nabq protectorate on Aqaba gulf, southern Sinai, Egypt.

The Two Subspecies

Caporiacco (1933) described the subspecies *Latrodectus pallidus immaculatus* from Gialo Oasis, Cufra in Libya. Levi (1959, p.38) stated that there is some doubt that *L. p. immaculatus* Caporiacco, 1933 from Libya is *L. pallidus*; it could be *L. geometricus*. Lotz (1994, p.43) stated that the type material of this subspecies is "not found". Due to this, Platnick (1997 & 2006) considered *L. p. immaculatus* a *nomen dubium*.

Brignoli (1983, p.386) and Platnick (1993, p.208) said that: *L. pallidus pavlovskii* Charitonov, 1954 (Turkestan) = *L. pallidus* O. Pickard-Cambridge, 1872 (Levi, 1959).

The Distribution

Levi (1959) mentioned that *L. pallidus* is recorded from Russia, Syria, Palestine, Iran, Egypt, Libya (Caporiacco, 1933), a doubtful record. And later (Levi, 1966, p.431), he said that: "*L. pallidus* is Near Eastern and eastern Mediterranean in distribution." It is also recorded from Turkey (Levy & Amitai, 1983), and "presumably in Syria, Jordan and Egypt (Sinai) but there are no explicit records" (Levy, 1998). Schmidt, et al. (1994) and Schmidt & Krause (1995) recorded *L. pallidus* from Cape Verde Islands. Knoflach & van Harten (2002, pp.351-353) recorded *L. pallidus* from Yemen too and said that "Its presence in Yemen is not surprising, but is based only on old museum specimens" (p.330).

Distribution of *Latrodectus pallidus* in different catalogues:
1. Roewer, 1942 (p.425): Tripoli, Egypt, Syria, Persian Gulf and *L. pallidus immaculatus* Cufra Oasis (Libya).
2. Platnick, 1989 (p.198) & 1993 (p.209): Libya to USSR.
3. Platnick, 1997 (p.277) & 2006: Cape Verde Is., Libya to Russia, Iran.

The record of *Latrodectus pallidu*s from Kherieza (28º10'N 34º21'E), Wadi Kid, in Nabq protectorate on Aqaba gulf, southern Sinai is the first explicit record from Egypt (El-Hennawy, 2002a, 2002b, 2003). The published record from Alexandria is not true. There is another record, 1♀ on August among stones, from northern Sinai, Abu El-Husein (31º04'26"N 33º30'39"E) - Zaranik Protectorate (El-Hennawy, 2005).

Being collected from Jericho (Palestine), it is not unexpected to find it in Amman (Jordan). It is another explicit record.

After excluding Alexandria (Egypt) and Libya from its distribution, it is obvious that *Latrodectus pallidus* is mainly "Near Eastern and eastern Mediterranean in distribution" as Levi (1966) stated before. The westernmost, Cape Verde Is., and southernmost, Yemen, records denote the wide distribution of this species, with many question marks ??? (Fig. 5).

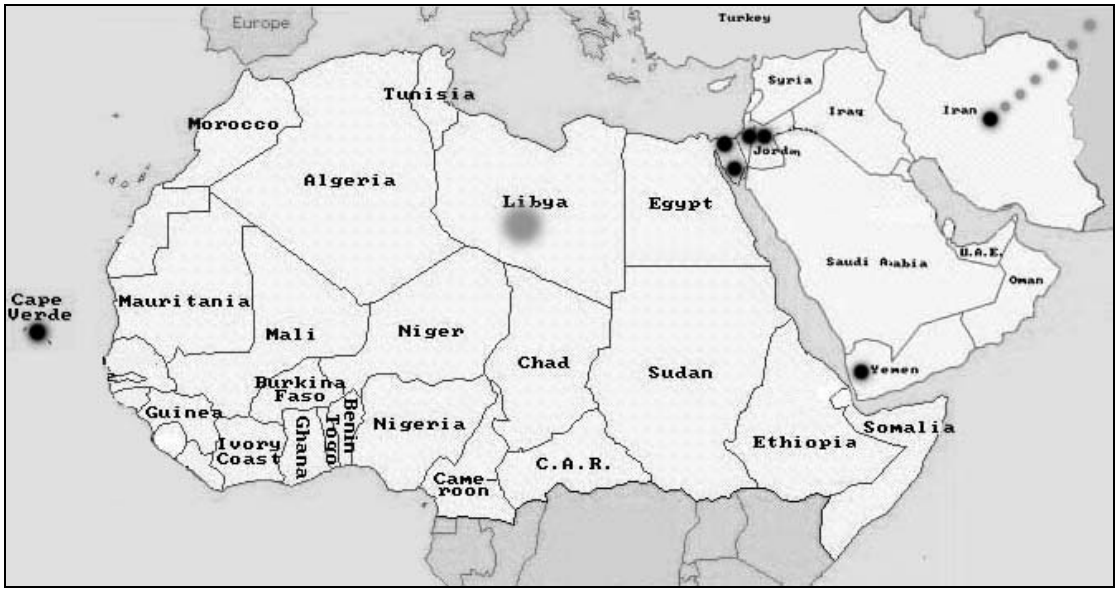

Fig. 5. Distribution map of *Latrodectus pallidus* O.P.-Cambridge, 1872 in the world.

The Web and its Situation

As summarized by Lotz (1994, p.43) according to Szlep (1965) "This species is found only in the desert which has some vegetation. … the retreat situated up to 60 cm above ground level … between twigs of the shrubs. … it has, in addition to the retreat, a special catching web." Its "clearly outlined coned retreat tapers obliquely above the catching web." (Levy & Amitai, 1983, p.59).

Knoflach & van Harten (2002, pp.328, 352) added: The web consists of a tube- to bell-shaped retreat spun of dry silk and the catching web containing the partially sticky catching threads (Szlep, 1965). The retreat and catching web are connected by an irregular, three-dimensional bridge layer. *L. pallidus* builds an elaborate retreat, which is 10-12 cm long. The web is constructed at a height of 30-60 cm between the twigs of shrubs (Szlep, 1965). From the retreat a bridge web leads 10-15 cm downwards to the comparatively small catching area. The catching web mainly consists of long (ca. 20 cm) vertical catching threads, which arise from a fine-meshed platform and reach the ground. At the bottom they are covered with viscid droplets for a distance of 2-5 cm (Szlep, 1965).

The female *Latrodectus pallidus* of Abu Nusseir, Amman (Jordan) was found inside her nest between two rocks (Fig. 2). Its retreat was vertically straight and attached

to an irregular snare below it. It was about 35 cm up of the ground. There were carcasses of beetles, mostly of family Tenebrionidae, on the ground surface under the web and attached to it.

The webs of *Latrodectus pallidus* in Wadi Kid, southern Sinai were found inside small stony caves (Fig. 4). It is obvious that webs of this species are not necessarily related to vegetation.

Colouration and Common Name

"The *abdomen* is of a creamy-white colour" O.P.-Cambridge (1872). "The abdomen looks leathery, possibly due to the white coloration" Levi (1959, p.38). The male has "black spots … on the pearly-white background" (Levy & Amitai, 1983, p.62).

Knoflach & van Harten (2002, p.330) said that *L. pallidus* is characterized "by its pale yellow colour". Hence, its "Common name: Pale widow" p.351.

The preserved museum specimens are really pale but alive ones have beautiful leathery white or light yellowish colour. The "White Widow" is something famous among amateurs now (e.g. www.arachnoboards.com). In fact, it is not fair to call *L. pallidus* a widow like the famous and dangerous "Black Widow". It may be called "White Bride" !!

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Biology, mass rearing and observations on the behaviour of *Kochiura aulica* (C. L. Koch, 1838) (Arachnida: Araneida: Theridiidae)

EL-Sayed H. Abdel-Karim [1], Gad H. H. Rady [1], Gamal A. Ibrahim [2] and Naglaa F. R. Ahmad [2]*

[1] Faculty of Agriculture, Banha University

[2] Plant Protection Research Institute, Agric. Research Center, Giza 12618, Egypt

Abstract

A stock culture of 150-200 individuals of *Kochiura aulica* (C.L. Koch, 1838) (Arachnida: Araneida: Theridiidae) was collected from olive trees in Giza governorate, Egypt. *K. aulica* adults were reared in plastic containers (1750 cc). All rearing units were supplied three times a week by adult fruit flies, *Drosophila melanogaster* Meigen, 1830. The newly hatched spiderlinges were reared on fruit fly adults until reaching adulthood.

Life cycle of *K. aulica* was studied individually and in groups under laboratory conditions (28±1°C and 75±10% R.H.), feeding on cotton leaf worm, *Spodoptera littoralis* (Boisduval, 1833), second larval stage. Also, adult fruit flies were only used in group rearing.

Incubation period averaged 13 days in individual and group rearing. Life cycle in individual rearing was 36.83 & 39.78 days for female and male, respectively. Life cycle in group rearing was 51.74 and 51.96 days, feeding on *S. littoralis* and *D. melanogaster* respectively. Egg sacs per female per day during the first 20 days of oviposition period in individual rearing was 3.00 egg sacs while in group rearing it was 0.91 & 1.66 egg sacs, feeding on *S. littoralis* and *D. melanogaster* respectively.

K. aulica showed a degree of sociality under laboratory conditions (in spite of lack to mothers brood care). It was high tolerance between individuals in all stages with no cannibalism. Egg sacs were laid and spread over rearing containers and were not attacked by other females. Newly hatched spiderlings aggregated in containers and showed cooperation in catching and feeding on available prey. This quasi-social behaviour seemed to be a survival strategy.

Mass rearing of *Kochiura aulica* was successful along more than two years.

Keywords: Spiders, Theridiidae, *Kochiura aulica*, Mass rearing, Social behaviour.

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* This article is a part of the Ph.D. Thesis of the last author (NA).

Corresponding author. E-mail contact: naglaaahmad@yahoo.com.

Introduction

Among the 110 families of spiders, Theridiidae is the fifth among six families which number of species exceeds 2000. Family Theridiidae includes 2227 species of 86 genera (Platnick, 2006). Genus *Kochiura* was described, in 1950. by Archer when he removed *Anelosimus* Simon, 1891 from the synonymy of *Theridion* Walckenaer, 1805. Now, it includes 8 species; 7 from South America and only *K. aulica* from Cape Verde Is. and Canary Is. in west Africa to Azerbaijan in Asia.

K. aulica was mainly described as *Theridion aulicum* by C.L. Koch in 1838, transferred to *Kochiura* by Archer in 1950, then to *Anelosimus* by Levi in 1956, and restored to *Kochiura* again by Agnarsson (2004). This species is considered a solitary species on the contrary of many permanent-social *Anelosimus* species, e.g. *A. eximius* (Keyserling, 1884) (Avilés, 1997). During our study, we found that the behaviour of this species is quasi-social. Hence, we decided to begin group or mass rearing of it. This may be the first step to get benefit of *K. aulica* as insect pests' predator, i.e. a biological control agent.

Material and Methods

Stock culture and mass rearing of *K. aulica*

The stock culture of *K. aulica* was collected from olive trees located in Giza governorate. Specimens' collecting began in July 2003, by collecting many of the spider nests containing a mixture of spiderlings, adults and egg sacs. About 150-200 adult individuals of *K. aulica*, in the ratio of 2♀ : 1♂, were transferred to 1750 cc plastic container to form a rearing unit. The central part of the container's cover was replaced by organza textile to facilitate ventilation.

All rearing units were supplied thrice a week by adult fruit flies, *Drosophila melanogaster* Meigen, 1830 (Diptera: Drosophilidae). The cotton leaf worm, *Spodoptera littoralis* (Boisduval, 1833) (Lepidoptera: Noctuidae), was also used as prey for both individual and group rearing. Egg sacs were collected, by means of a soft brush, from the stock culture before feeding and were transferred to glass tubes of 5 cm diameter and 10 cm height until hatching. The newly hatched spiderlings were counted and each 50 individuals were transferred to a small glass container, 250 cc, covered by muslin or organza and fed on adult fruit flies. As the new hatch reached the third spiderling instar, the contents of each 3-4 containers were transferred to larger glass containers, 7 cm diameter and 20 cm height, covered by muslin or organza and were fed in the same way until reaching adulthood. Adults were then transferred to plastic containers for mating and egg laying. Rearing continued since July 2003 until February 2006.

Production of *Drosophila melanogaster*

Laboratory strain of *D. melanogaster* was obtained as adults from the Faculty of Agriculture, Ain-Shams University, Cairo, Egypt. All stages were kept in 500 cc glass jars covered by muslin and cultured on artificial diet under laboratory conditions (28±1°C and 70±10% R.H.). The used diet consisted of: 100 g corn flour, 100 g can sugar, 20 g dried yeast, and 1000 ml water to be boiled for 5-10 min. Five grams of agar was separately ripped in 250 ml water in a water bath and added to the previous mixture. Traces of methyl-4-hydroxy-benzoate and ascorbic acid were added. The prepared diet was then poured down inside the glass jars to form a layer of 4-5 cm in depth. Jars were left to cool down to room temperature before introducing adult fruit flies.

Production of *Spodoptera littoralis*

Laboratory strain of *S. littoralis* was obtained as egg masses and larvae from the Economic Entomology and Pesticides Department, Faculty of Agriculture, Cairo University. All stages were kept in glass jars (20 cm height and 12.5 cm diameter) covered by muslin and cultured under room temperature.

Larvae were reared on leaves of castor-oil plant, *Ricinus communis* (L.), which were washed in running water and dried before being placed in rearing jars. Larvae faeces were removed and *R. communis* old leaves were replaced by new ones every two days. As larvae reached the fifth larval stage, saw dust was placed in the jars to absorb any excess moisture and to allow pupation at the end of larval stage. Pupae were collected and put in separate jars under the same conditions.

The newly emerged males and females were allowed to mate. The rearing jars were lined with paper to provide an egg laying site and daily provided with cotton pads moistened with 10% honey solution for the nutrition of the adults. Egg masses laid on the paper were daily removed and transferred to clean jars. Second larval stage produced from these egg masses were used as prey for *K. aulica* in both individual and group rearing.

Life cycle of *Kochiura aulica*

A. Individuals rearing

Life cycle of *K. aulica* was studied individually under laboratory conditions (28±1°C and 75±10% R.H.), feeding on *S. littoralis*. Bottomless clear plastic containers (30 cc) were prepared by covering both ends with organza textile. One end was fixed while the other was removable. These units were designed to be used in experiments with controlled humidity. Twenty newly hatched spiderlings were reared individually; each one in its container and fed three times a week. Replicates were put in larger containers containing over-saturated NaCl solution (Winston & Bates, 1960) and were monitored for moulting, survival and reaching maturity. Life cycle duration was recorded in addition to number of egg sacs and sex ratio (males/total).

B. Groups rearing

Life cycle of *K. aulica* was studied in groups under the same laboratory conditions on two kinds of prey, i.e. *D. melanogaster* adults and *S. littoralis* second larval stage. Bottomless clear plastic containers (300 cc) were prepared in the same way as in individuals rearing. Thirty newly hatched spiderlings were reared together in each container as one group. Each group was fed three times a week. The experiments were replicated 15 times on *D. melanogaster* and 20 times on *S. littoralis*. Replicates were put in larger containers containing over-saturated salt solution for humidity control. Units were monitored for moulting, survival and reaching maturity. Life cycle duration, sex ratio and number of egg sacs were recorded per groups.

Egg sacs were collected before feeding and were transferred into glass tubes (5 cm in diameter and 10 cm in height) and incubated under the same conditions until hatching. Observations during oviposition period were terminated in case of feeding on *S. littoralis* (Fig. 1) because of lack of prey at the mid of the experiment. They were also terminated after a period that equals the spider's generation time as suggested by Abou-Setta & Childers (1991) for reaching the maximum value for intrinsic rate of increase for fauna which lave a long period of oviposition.

Results

Mass rearing of *K. aulica*

The study of the life cycle of *K. aulica* in groups acted as a small scale of mass rearing to compare the quality of this type of rearing with individuals rearing. Obtained results indicated that incubation period averaged 13 days in the two types of rearing, feeding on *S. littoralis*. Total spiderlings duration in individuals rearing (23.83 & 26.78 days for females and males) was shorter than in groups (38.93 & 38.63 days, feeding on *S. littoralis* and *D. melanogaster*, respectively). On the other hand the average number of egg sacs per female in groups rearing during the first 20 days was less than in individuals rearing (0.91 compared with 3.00) (Table 1, Fig. 1). The survival, i.e. proportion of individuals reached maturity, of *K. aulica* reared in groups ranged between 0.4 and 0.83 compared with individuals rearing, i.e. 0.94 (Table 1).

Table 1: Biological results of rearing *Kochiura aulica* under different circumstances.

Prey type	*Drosophila melanogaster* (groups)		*Spodoptera littoralis* (groups)		*Spodoptera littoralis* (individuals rearing)			
					male		female	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Incubation period	13.03	1.10	13.00	0	13	0	13	0
Spiderlings duration	38.93	7.29	38.63	4.36	26.78	2.99	23.83	3.97
Life cycle	51.96	7.29	51.74	4.36	39.78	2.99	36.83	3.97
Fecundity ratio 1-20	1.66	0.75	0.91	0.61	-	-	3.00	0.63
Fecundity ratio 1-40	4.16	1.31	-	-	-	-	8.17	1.84
Sex ratio (♂♂/total)	0.38	0.09	0.39	0.09	0.59			
Survival ratio	0.65	0.08	0.65	0.13	0.94			

Fecundity ratio = Number of egg sacs per female per day, 1-20/1-40 = during the first 20/40 days of female's oviposition period, Survival ratio = proportion of individuals reached maturity.

Effect of prey on life cycle of *K. aulica* reared in groups

Total developmental duration averaged 38.93 and 38.63 days for spiders reared in groups feeding on *D. melanogaster* and *S. littoralis* respectively (Table 1). Survival in the first case ranged between 0.57 and 0.87 (0.65 ± 0.08) and ranged between 0.4 and 0.83 (0.65 ± 0.13) in the second case (Table 1).

Effect of prey on reproduction

Average number of egg sacs per female per day during the first 20 days of oviposition period was 1.66 and 0.91 for spiders reared in groups feeding on *D. melanogaster* and *S. littoralis* respectively while the average became 4.16 during the first 40 days with feeding on *D. melanogaster* (Table 1). The comparison of numbers of egg sacs per female per day under different circumstances is illustrated in Fig (1).

Effect of rearing method on sex ratio

Sex ratio (males/total) of *K. aulica* which reared in groups was 0.38 and 0.39 when fed on *D. melanogaster* and *S. littoralis* respectively compared with 0.59 in case of individuals rearing.

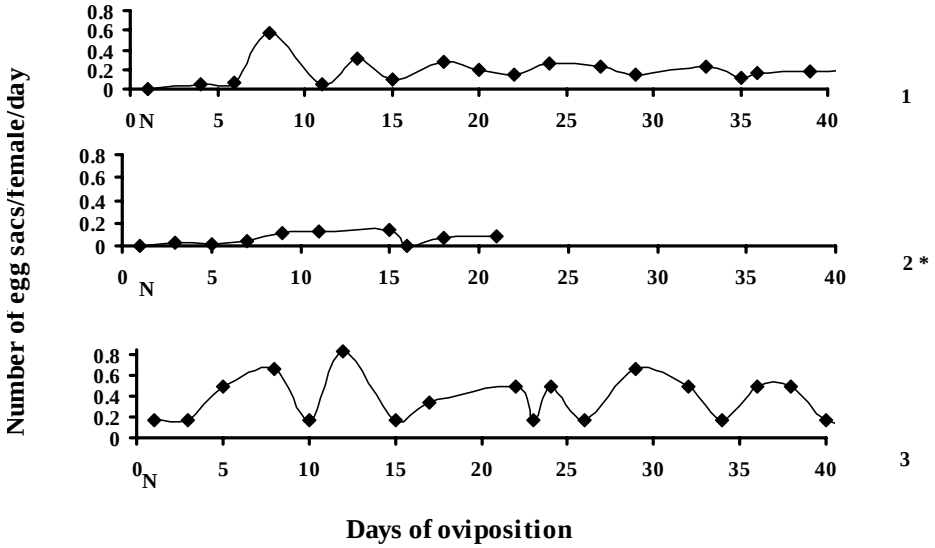

Fig. 1. Number of egg sacs per female of *Kochiura aulica* per day during the oviposition period. N = First egg sac. 1, 2. Groups rearing. 3. Individuals rearing.
1. Feeding on *Drosophila melanogaster*. 2, 3. Feeding on *Spodoptera littoralis*.
* = Observations were terminated because of lack of prey.

Notes on the behaviour of *K. aulica* under laboratory conditions

A degree of sociality was observed in *K. aulica* behaviour under laboratory conditions. The behaviour reported herein is for adults and spiderlings as well.

Quasi-social behaviour in adults

1. High degree of tolerance between individuals occurred when large numbers (150-200) of field-collected individuals were reared in a small container (1750 cc). No cannibalism was observed, not only when they were fed three times a week, but also under starvation for 15 days.
2. When a small prey, i.e. adult *Drosophila* sp. or *S. littoralis* second instar larva, was introduced to a group of adult spiders, catching prey and feeding accrued by single individual and in some cases two individuals shared the same prey. When a relatively larger prey, as adult fruit fly *Ceratitis capitata* (Wiedemann, 1824), was introduced, more than one individual cooperated in capturing it and later many of them fed on it (Fig. 2).
3. Egg sacs laid by females were spread out all over rearing containers and were not attacked by other females. Even more, females prevented some males from coming near maturing egg sacs, but they did not kill them.

Quasi-social behaviour in spiderlings

1. When large numbers of newly hatched spiderlings (50) were transferred to a small container (250 cc), they aggregated in the upper part of it, and made a common web.

2. Whenever a prey was available, more than one cooperated in catching it regardless of its size. As it was captured, more individuals fed on it at the same time to the degree that in some cases they covered the prey's body (Fig. 3).
3. The individuals divided themselves into small groups during feeding according to the prey's size. After feeding, spiderlings went back to make one group again.
4. Presence of less than three first instar spiderlings was not enough to catch an adult *D. melanogaster*.
5. Reaching the third instar, spiderlings began to disperse in the whole container and hunted individually or in small groups according to prey's size.

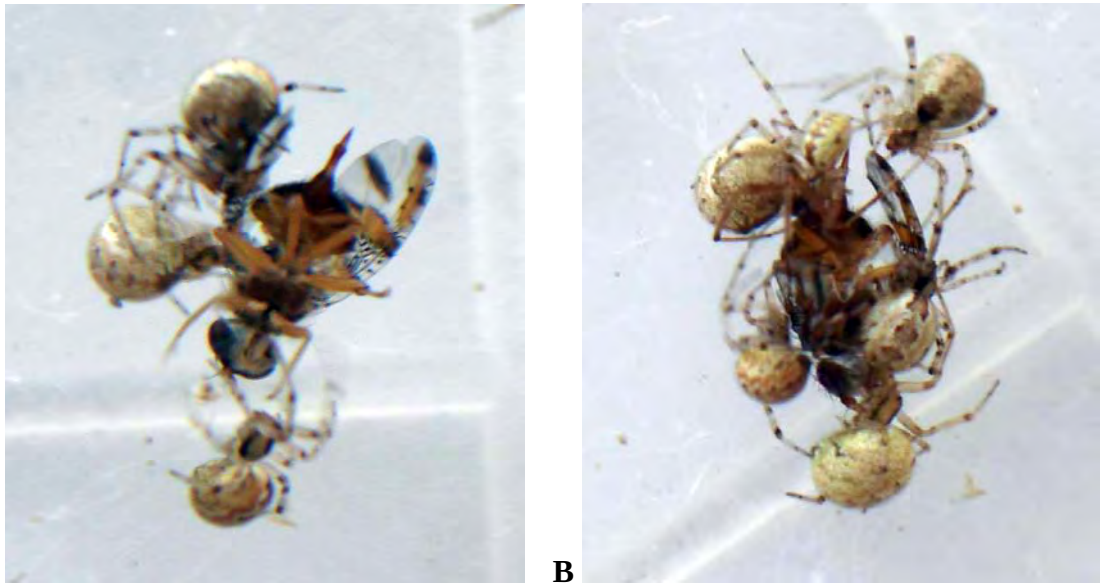

Fig. 2. *Kochiura aulica*, adults cooperate in attacking a *Ceratitis capitata* fruit fly.
A. At the beginning. B. After a few minutes.

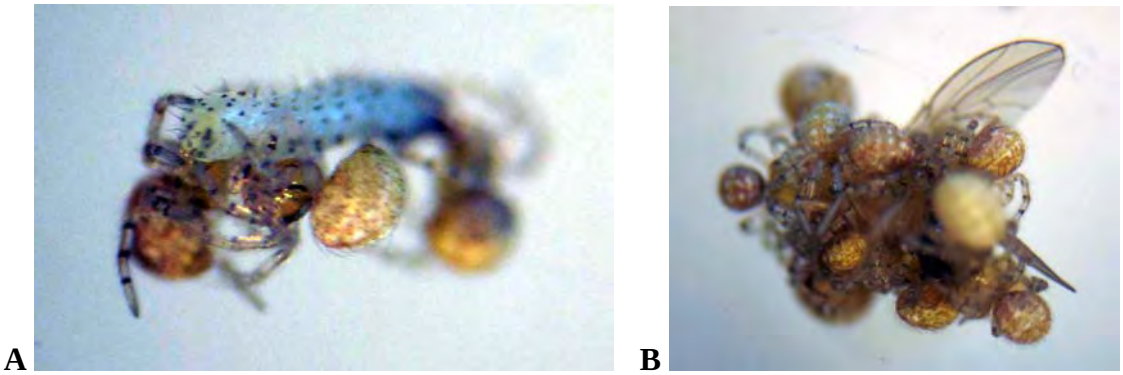

Fig. 3. *Kochiura aulica*, juveniles cooperate in attacking: A. *Spodoptera littoralis*, larva, B. *Drosophila melanogaster*, fruit fly.

Discussion

Mass rearing method

Observing the quasi-social behaviour of *K. aulica* under laboratory conditions led to the idea of mass rearing of this species. Tolerance among individuals in all stages was the main character. Egg sacs and newly hatched spiderlings did not need mother brood

care. Newly hatched spiderlings cooperated in catching and feeding on available prey. Used mass rearing method was easy and inexpensive because the fruit fly *D. melanogaster* can be reared on artificial diet with high reproduction rate. *D. melanogaster* was used as a common prey in rearing of many spider species (Jackson, 1974).

In the used method, 150-200 adults/plastic container (1750 cc) with sex ratio of 2♀: 1♂ (i.e. 8.75-11.66 cc per individual) were fed three times a week on the fruit fly adults. Dinter (2004) stated that rearing of spiders is very time-consuming and laborious, because of cannibalism and the need to supply living prey. In his mass rearing method for *Erigone atra*, he used a plastic container (12x16.5x5 cm) for every 20-40 adults, i.e. 24.77-49.55 cc per individual. These individuals were fed on Collembola as a continuous available prey. In addition *D. melanogaster* was added once a weak. In Dinter's method, in his larger containers, 59.3% reached adulthood compared with 65% in this method.

Life cycle of *K. aulica*

Obtained results of spiderlings duration seem to be the shortest compared with published results for *K. aulica*, i.e. 26.78 and 23.83 days for male and female, respectively, reared individually feeding on *S. littoralis* second stage larvae.

K. aulica was reared individually by Rahil & Hanna (2001) under laboratory conditions (27±1°C and 57.7% R.H.) feeding on 3rd and 4th larvae of the coleopteran *Tribolium confusum*. They reported 32.62 and 33.33 days for male and female respectively. El-Erksousy *et al*. (2002) reared *K. aulica* under laboratory conditions (26±2°C and 60-70% R.H.) feeding on *S. littoralis* larvae and reported 44.2 and 47.2 days for male and female, respectively. Hussein *et al*. (2003) reared *K. aulica* at room temperature, during different seasons feeding on the acarine *Tetranychus urticae*, the aphid *Aphis craccivora* and mixed diet of them. They recorded 57.1 and 62.45 days for male and female during summer feeding on mixed diet, 60.83 and 69 days for male and female during summer feeding on *A. craccivora.* They recorded the longest duration during winter feeding on *A. craccivora* and the mixed diet as 185, 160.8 and 190, 167.93 days for male and female, respectively. Mohafez (2004) reared *K. aulica* at room temperature on *Achroia grisella* and reported 62.43 and 64.1 days for male and female, respectively.

Egg incubation period in the used method was 13 days compared with a range between 9.6 and 12.8 days in the published papers of Rahil & Hanna (2001), El-Erksousy *et al*. (2002), Hussein *et al*. (2003), and Mohafez (2004).

These results may reveal that constant temperature and humidity during rearing had an evident effect on life cycle duration. Also, the kind of prey affected life cycle duration.

Obtained results indicate that juveniles of *K. aulica* which were reared individually developed faster than those reared in groups. These results are in agreement with Thomas & Parker (2000). Life history durations of *K. aulica* in groups fed on *D. melanogaster* or *S. littoralis* were approximately similar. Rearing in groups reduced the males' percentage and decreased the number of egg sacs per female. This result is in agreement with Smith & Hagen (1996).

Quasi-social behaviour

K. aulica appeared to have tolerance and cooperation among its individuals. Tolerance in spiders is considered as a degree of sociality (Darchen & Delage-Darchen, 1986; Riechert *et al*., 1986; Rypstra, 1986; Seibt & Wickler, 1988; Rypstra & Tirey, 1989; Foelix, 1996; Avilés & Salazar, 1999; El-Hennawy & Mohafez, 2003). *K. aulica* individuals cooperated in capturing any available prey. More than three first instar spiderlings were required to subdue an adult *D. melanogaster*. This quasi-social

behaviour seemed to be survival strategy. Amir *et al*. (2000) said that "Social spiders cooperate in capturing prey which is then consumed by a group of individuals. By cooperating, they can handle larger prey than most similar-size solitary species." and "In social spiders many individuals can feed on the same prey". Foelix (1996) stated that "Prey catching in *Agelena consociata* is also communal. … When prey falls on the sheet web, its movements attract the attention of all spiders in the vicinity. If the prey is small … only a single adult spider rushes in, grasps the victim, bites it ... If a larger prey … mostly adult spiders attack it". This means that *K. aulica* shows a degree of sociality in spite of having no sign of mother's brood care, the thing which is considered necessary to sociality (Foelix, 1996). This case of sociality suggests that tolerance is the first degree of sociality. These results are in agreement with Kullmann *et al*. (1972) and El-Hennawy & Mohafez (2003).

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Life history of *Cheiracanthium isiacum* O.P.-Cambridge, 1874 (Arachnida: Araneida: Miturgidae) in Egypt

Mohammad A. Mohafez
Faculty of Agriculture, Al-Azhar University, Cairo, Egypt
E-mail: mohamedmohafez@yahoo.com

Abstract

Cheiracanthium isiacum O.P.-Cambridge, 1874 was reared under laboratory conditions, 26-28ºC and 60-70% R.H. After incubation period of 19 days, there were 7 spiderling instars before reaching adult male and 8 instars before reaching adult female. The second instar spidrling was the longest period, 21.1 and 20.90 days for male and female, respectively, while the third spiderling instar was the shortest period, 14.4 and 14.3 days for male and female, respectively. The total period of spiderlings was shorter for male (119.6 days) than female (133 days). Adult longevity and life span were shorter for male than for the female. The female produced 4.72 egg sacs, each one contained 87-130 eggs. A mixture of larvae of *Spodoptera littoralis* and *Galleria mellonella* was used for feeding all spiderling instars until reaching adult stage. The food consumption of different spiderling instars was recorded. Feeding *C. isiacum* on *Drosophila melanogaster* flies and *Tetranychus urticae* mites was not successful and spiders did not reach adult stage.

Keywords: Spiders, Miturgidae, *Cheiracanthium isiacum*, life history, Egypt.

Introduction

Individuals of *Cheiracanthium isiacum* O.P.-Cambridge, 1874, family Miturgidae, are found on different plants in several governorates in Egypt, e.g. on mango, grapes, citrus, and guava, in Sohag, Giza, and Fayoum governorates. They are always found on the middle of trees and they live in association with different insects and mites infesting orchards.

In Egypt, Rahil (1988) studied the biology of *Cheiracanthium jovium* Denis, 1947 under different temperatures, relative humidity, and prey. Incubation period, hatching percentage, number of moults, oviposition and post-oviposition periods, mating behaviour and sex ratio were observed.

Rakha *et al*. (1999) also studied the biological aspects of *Cheiracanthium jovium* at 25°C and 60-70% R.H. They mentioned that female spider, during its limited oviposition period, deposited about 300-350 eggs in one sac. The incubation period

averaged 14.1 days. Females had 8-9 spiderling instars before reaching maturity and the developmental duration averaged 230.6 days. Pre-oviposition and post-oviposition periods were 70 and 77.1 days, respectively. Thus, the total female life span averaged 387.6 days. Male passed through 7-8 spiderling instars with developmental period averaged 169.7 days.

Material and Methods

Adult females and gravid female spiders of *Cheiracanthium isiacum* O.P.-Cambridge, 1874 were collected and reared under laboratory conditions, 26-28ºC and 60-70% R.H. Spiders were kept in translucent plastic containers (3cm diameter x 5cm height), and supplied with prey. Rearing continued until gravid females laid their eggs.

For individual rearing, newly hatched spiderlings were kept together until the first moulting. After that, they were transferred to separate single rearing smaller cells (1 x 5 cm). A mixture of the larvae of the cotton leaf moth *Spodoptera littoralis* (Boisduval, 1833) and the greater wax moth *Galleria mellonella* (Linnaeus, 1758) was used for feeding all spiderling instars until reaching adult stage. First instar spiderlings of *C. isiacum* were fed together, a communal or group feeding, on 1st and 2nd instar larvae of both *S. littoralis*, *G. mellonella*. The 2nd and 3rd instar spiderlings were fed on 2nd and 3rd instar larvae, 4th instar spiderlings were fed on 4th instar larvae, 5th- 8th instar spiderlings were fed on biggest size of larvae. The adults also were fed on the same prey along their longevity.

The adult fruit flies, *Drosophila melanogaster* Meigen, 1830, and the two-spotted spider mites, *Tetranychus urticae* (Koch, 1836), were also used for feeding in two separate experiments to evaluate their efficiency as prey to *C. isiacum*.

Table 1: Duration of different stages of *Cheiracanthium isiacum* O.P.-Cambridge, 1874.

Developmental stage	Prey	Duration (days)			
		Male		Female	
		Mean	S.D.	Mean	S.D.
1st spiderling instar	Mixture of larvae of *Spodoptera littoralis* and larvae of *Galleria mellonella*	17.2	0.42	18.8	0.6
2nd spiderling instar		21.1	1.37	20.9	1.30
3rd spiderling instar		14.4	2.50	14.3	2.90
4th spiderling instar		16.7	2.11	15.2	1.6
5th spiderling instar		17.4	2.27	17.18	2.22
6th spiderling instar		18.2	0.89	17.54	3.1
7th spiderling instar		16.2	1.78	15.63	1.28
8th spiderling instar		---	---	14.5	2.06
Total instars		119.6	6.14	133	5.19
Life cycle		138.6	6.14	152	5.19
Adult longevity		30.8	12.26	152.27	22.30
Life span		169.4	12.46	304	30.20

Results

Spiderlings emerge from the egg sac after incubation period of 19 days. The spiderlings moult 7 times to reach adult male and 8 times to reach adult female (Table 1). The first spiderlings stayed with their mother for 5-10 days. They did not feed during their first days. The duration period of first spiderling averaged 17.2 and 18.8 days for

male and female, respectively. When the first spiderling became full grown, it stopped feeding before moulting to the second spiderling which had the longest period, i.e. about 21.1 and 20.90 days for male and female, respectively. The third spiderling instar was the shortest period with the values of 14.4 and 14.3 days for male and female, respectively. The total period of spiderlings was shorter for male (119.6±6.14 days) than female (133±5.19 days).

Adult longevity is also different according to sex. Generally, male lived a shorter period than female. Adult male longevity ranged from 14-50 days with an average of 30.8 days, while that of the female's longevity ranged from 116-183 days with an average of 152.27 days. The life span is evidently shorter in case of males than females. It was 169.4±12.46 and 304±30.20 days for male and female, respectively (Table 1).

Table 2: Fecundity of the female spider *Cheiracanthium isiacum*.

Parameters		Mean	S.D.
Pre-oviposition	Days	12.90	2.58
Oviposition		75.45	11.78
Post-oviposition		64.45	24.22
Eggs / egg sac	Eggs	106	19.09
Total number of eggs / female during longevity		424	19.09

Oviposition and fecundity

About 20 days after copulation, the female laid her eggs inside an egg sac (a cocoon). The female produced 4-6 egg sacs (average: 4.72) during her oviposition period. The period between each two egg sacs ranged 13-32 days (average: 18.6 days). The oviposition period was 53-93 days (average: 75.45 days). The post-oviposition period was 11-92 days (average: 64.45 days). Number of eggs in each egg sac ranged 87-130 eggs with an average of 106 eggs. The total number of eggs/female was about 424 eggs (Table 2). In case of the females reared and developed in the laboratory, the number of eggs/egg sac was 18-35 eggs (average: 23.83 eggs), and the average of total number of eggs/female was 143 eggs. This elucidates the effect of laboratory rearing on the fecundity of *C. isiacum* females.

Table 3: Daily rate of food consumption of *Cheiracanthium isiacum* in laboratory.

Developmental stage	Prey	Male		Female	
		Mean	S.D.	Mean	S.D.
1st spiderling instar	Mixture of larvae of *Spodoptera littoralis* and larvae of *Galleria mellonella*	Communal (group) feeding			
2nd spiderling instar		3.6	1.8	4.72	2.36
3rd spiderling instar		5.1	2.55	5.90	2.92
4th spiderling instar		6.4	3.2	7.8	3.9
5th spiderling instar		6.6	3.3	7.0	3.5
6th spiderling instar		7.0	3.5	7.63	3.81
7th spiderling instar		4.3	2.15	5.81	2.90
8th spiderling instar		---	---	6.36	6.36

Food consumption

The communal or group feeding of the 1st instar spiderlings of *C. isiacum*, on a mixture of the larvae of both *S. littoralis* and *G. mellonella*, did not permit the calculation of the daily rate of consumption. The daily rate of consumption of larvae by 2nd-8th instar spiderlings is recorded in table (3). The average number of consumed larvae and the daily

rate of consumption increased during 4th-6th instars, to drop again in the 7th instar. *C. isiacum* is quick in attacking its prey, seizing it after the head or at its other end of the body. Feeding on one larva needs about 2-3 minutes.

Feeding on other kinds of prey

Two groups of 1st instar spiderlings of *C. isiacum* were reared feeding on the fruit flies, *Drosophila melanogaster*, and the spider mites, *Tetranychus urticae*. All individuals of the first group died during the 1st instar except two spiderlings only which reached the 3rd instar. The size of adult *D. melanogaster* flies may be not suitable, as prey, to the 1st instar spiderlings which are smaller than them.

The spiderlings of the second group, feeding on *T. urticae*, were in a better situation. The periods of 4th to 6th instars became longer (Table 4) and the mortality increased since the 3rd instar to reach 60% in the 6th instar. All individuals died before reaching adulthood. It was not possible to count the number of mites consumed because uncountable colonies of *T. urticae* on castor oil leaves were used for feeding.

Table 4: Duration of immature stages of *Cheiracanthium isiacum*, feeding on *Tetranychus urticae* mites.

Stages	Prey	Duration of different stage			
		Male *		Female	
		Mean	S.D.	Mean	S.D.
1st spiderling instar	Spider mite *Tetranychus urticae*	17.16	0.40	18.28	0.48
2nd spiderling instar		18.5	1.64	20.14	1.34
3rd spiderling instar		15.33	2.58	13.85	2.96
4th spiderling instar		17.33	3.72	23.0	3.05
5th spiderling instar		23.0	1.67	21.14	4.22
6th spiderling instar		20.33	1.63	20.14	1.95
7th spiderling instar		---	---	14.57	2.29
All individuals died before reaching adulthood.					

* Subadult males had inflated pedipalps in 6th spiderling instar.

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